National Park Service
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Natural Resource Stewardship and Science

Intertidal Monitoring Protocol for the North Coast and Cascades Network

Natural Resource Report NPS/NCCN/NRR—2012/512

ON THE COVER

From top left clockwise: Intertidal habitat near Sokol Point, OLYM; exposed dissipative sand flats on Second Beach, OLYM; Rock platform intertidal monitoring at Taylor Point, OLYM.

Photographs by: Steven Fradkin.

Intertidal Monitoring Protocol for the North Coast and Cascades Network

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Revision Date	Author	Changes Made	Reason for Change
March 2009	S. C. Fradkin	---	Original
Jan 2010	S. C. Fradkin	Various revisions	Admin & Peer Review Comments
Dec 2012	J. R. Boetsch	Chapt. 4 Data Management	Update content to current NPS standards
Jan 2012	S. C. Fradkin	Minor edits and figure adjustments	Preparation for publication in NRR series

Abstract

The intertidal zone of the Pacific Northwest is one of the most productive and diverse marine habitats on the west coast of North America. Prime examples of pristine outer coast and Puget Sound intertidal habitats and their intact biota are found within the boundaries of the marine parks of the North Coast and Cascades Network (NCCN) of national parks. These rich resources are vulnerable to a variety of threats, especially climate change and oil spills. A rich history of intertidal monitoring exists within the NCCN and at other west coast sites, both inside and outside of NPS units. This foundation has been drawn upon to develop a monitoring protocol to track trends in the invertebrate and macroalgal communities of major intertidal habitats (rocky shorelines and sand beaches) and intertidal water temperature in Olympic National Park (OLYM), San Juan Island National Historical Park (SAJH), and Lewis and Clark National Historical Park (LEWI). We have established 7 sites to monitor rocky intertidal target species and communities in OLYM, LEWI and SAJH. Each site is part of the MARINe (Multi-Agency Rocky Intertidal Network) network and contains plots that target the abundance of key habitat-forming species and a keystone seastar predator (*Pisaster ochraceus*). These plots follow established MARINe methodologies and allow comparison to other MARINe sites along the west coast of North America. Additional plots in OLYM target whole communities to track trends in their composition and elevational distribution, aspects predicted to be altered by climate change. Eight sand beach sites have been established in OLYM and LEWI to detect trends in infaunal community structure, and 14 temperature sites have been established to track changes in intertidal water temperature in each distinct oceanographic zone in OLYM, LEWI, and SAJH. Monitoring of intertidal biota and the dominant physical factor influencing them provides an important baseline for assessing the impacts of oil spills and understanding the impacts associated with global climate change. Such understanding can be incorporated into park management decisions and adaptation strategies.

Acknowledgments

Marine monitoring has a long history in the NCCN, particularly in Olympic National Park. A debt of gratitude is owed to Dr. Megan Dethier for establishing the monitoring program at OLYM and for her continued contributions to the science of intertidal monitoring. The power analysis of historical monitoring data at OLYM was funded by the USGS Biological Resources Division, Forest and Rangeland Ecosystem Science Center under the supervision of Dr. Andrea Woodward. The power analyses were conducted by Ryan Nelson and Lyman McDonald of West Inc. The MARINe Target Species and Sea Star monitoring standard operating procedures (SOPs 1 and 2) were adapted from the MARINe protocols manual (Engle 2005) and the Klamath Network (KLMN) rocky intertidal monitoring protocol for Redwoods National Park (Ammann and Raimondi 2008). Dr. Pete Raimondi, Melissa Miner, Hazel Levine, Dr. Jim Agee and two anonymous reviewers provided valuable comments on a draft version of the protocol.

Introduction

This protocol narrative outlines the rationale, sampling design and methods proposed for intertidal monitoring in the North Coast and Cascades Network (NCCN) as part of the Inventory and Monitoring Program. In 2000, the National Park Service initiated a long-term ecological monitoring program to track key indicators of ecosystem health, or “vital signs”. These indicators are measurable parameters that may provide warning of changes that can impair the long-term stability and character of natural park ecosystems (NPS 2001). The Inventory and Monitoring program is organized nationally around 32 monitoring networks including approximately 270 park units. As one of these networks, the NCCN is composed of 8 NPS units including the marine parks Ebey’s Landing National Historical Preserve (EBLA), Lewis and Clark National, Historical Park (LEWI), Olympic National Park (OLYM), and San Juan Island National Historical Park. Since 2000, numerous monitoring workshops and meetings have been conducted in the NCCN to identify key park ecosystem components and core indicators within each ecosystem component, in addition to allocating limited monitoring funding to the development and implementation of monitoring protocols (NPS 2005). As part of this process, the intertidal zone was identified as one of the park ecosystem components for protocol development. However, due to differences in the NCCN marine parks relative to their intertidal habitats and their jurisdictional boundaries, and due to limited network funding that restricts the scope of habitats that can be effectively monitored, this protocol applies only to three of the NCCN parks—LEWI, OLYM, and SAJH. EBLA is not included in this protocol because the intertidal zone within the park boundaries (Penn Cove) has predominantly soft-sediment and estuarine substrates that are not appropriate for the standard operating procedures presented here.

The structure and content of this protocol adhere to the outline and recommendations adopted by the NPS in Oakley et al. (2003). Methodological details of the protocol are addressed in a set of standard operating procedures (SOPs) found at the end of the document, along with appendices containing additional supporting materials referenced in the narrative section.

1. Background and Objectives

A. Background and History

The North Coast and Cascades Network (NCCN) of national parks is rich in marine resources, with 3 of the 8 network parks containing important intertidal zones within their boundaries. These marine parks – Lewis and Clark National Historical Park (LEWI), Olympic National Park (OLYM), and San Juan National Historical Park (SAJH, Figure 1) – encompass a diverse array of intertidal habitats, from open coast rock, sand, and cobble beaches, to protected Puget Sound rock, gravel, and soft sediment beaches.

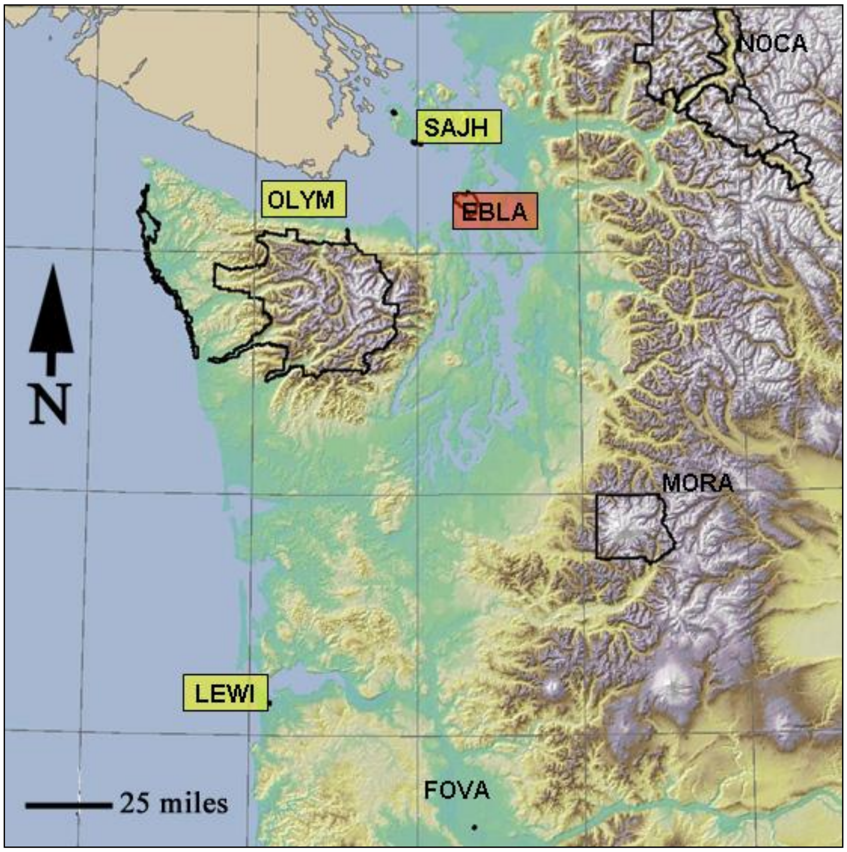

Figure 1. NPS units of the North Coast and Cascades Network. Marine parks are highlighted, with parks included in this protocol highlighted in yellow.

The intertidal zone, an area inundated and exposed twice daily by the tide, is tightly linked to both terrestrial and nearshore marine ecosystems. Oceanographic processes, such as upwelling on the open coast and complex tidal currents in Puget Sound strongly influence the biota in these areas (Thomson 1994, Hickey and Banas 2003). The Pacific Northwest hosts the highest diversity of intertidal invertebrates and seaweeds on the west coast of North America (Schoch et al. 2006). Intertidal organisms have evolved myriad adaptations to life in a harsh wave-swept environment, yet these organisms are highly susceptible to a wide range of anthropogenic stressors, including oils spills, exotic species introductions, aquaculture, eutrophication, shoreline modification, and global climate change. The nearshore ocean of the Pacific Northwest is highly impacted by anthropogenic stressors (Halpern et al. 2008). These stressors have the potential to alter oceanographic processes, physiological tolerances, and predator-prey and competitive interactions. A stressor-based conceptual model of the NCCN intertidal zone is presented in Figure 2. Oil spills, in particular, have long been a concern of NCCN park managers and were the primary reason for the start of intertidal monitoring activities in OLYM in 1988. All of the marine NCCN parks are situated along major travel routes for commercial shipping traffic, including oil tankers, bound for the ports of Vancouver (Canada), Seattle, and Portland. The Olympic coast experienced major oil spills in 1988 (*Nestucca)* and 1991 (*Tenyo Maru*).

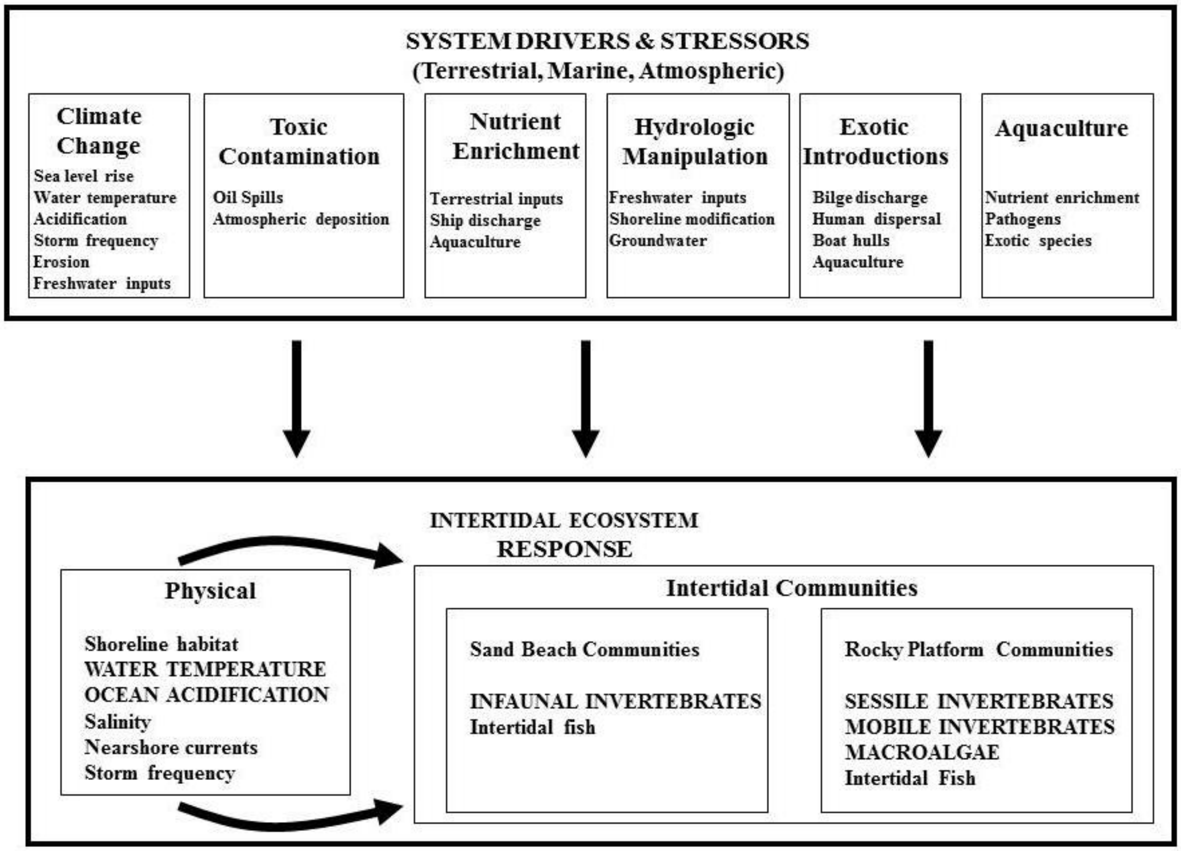

Figure 2. Anthropogenic stressor-based conceptual model of NCCN intertidal ecosystems. Ecosystem responses in all capital letters are addressed in this protocol.

Historical NCCN Intertidal Monitoring

Lewis and Clark National Historical Park (LEWI)

LEWI, located at the mouth of the Columbia River and the northern Oregon coast (Figure 3), was established by Congress in 1958 as Fort Clatsop National Memorial, and was subsequently expanded and renamed in 2004 as Lewis and Clark National Historical Park. The 2004 expansion added several state parks that included significant intertidal areas, particularly Ecola State Park (6 miles), Sunset Beach (0.6 miles), and Fort Stevens (4.6 miles) and Cape Disappointment (3.3 miles). These shorelines are spread over 40 miles of Oregon and Washington Pacific coastline. The intertidal areas encompass a variety of habitats, including rocky cliffs, rocky platforms, high energy fine sand beaches, and gravel beaches. The Fort Stevens and Cape Disappointment shorelines are heavily influenced by freshwater inputs from the Columbia River (Hickey and Banas 2003). No NPS intertidal monitoring has been conducted at LEWI (Klinger et al. 2007a), however two research groups, the Multi-Agency Rocky Intertidal Network (MARINe) and the Partnership for the Interdisciplinary Study of Coastal Oceans (PISCO), established rocky intertidal monitoring sites at Ecola State Park in the early 2000s as part of their regional, coast-wide monitoring programs. The MARINe site at LEWI has been incorporated into this protocol as the LEWI MARINe Rocky Target Species site (Figure 3). The PISCO biodiversity monitoring site is an intermittently sampled site that is not part to this protocol.

Figure 3. Site map of Lewis and Clark National Historical Park (LEWI). Proposed monitoring sites are denoted by symbols. Where rock and temperature symbols are adjacent, temperature loggers are co-located on the same beach segments.

Olympic National Park (OLYM)

The coastal unit of OLYM, located on the outer Pacific coast of northwest Washington on the Olympic Peninsula (Figure 4), has approximately 70 miles of diverse intertidal habitats, including cliffs, rocky platforms, boulder field, cobble beaches, gravel beaches, sand/gravel beaches, high energy fine sand beaches, and several small estuaries. If the coastal strip of OLYM were a separate NPS unit, it would be the 4th largest park in the NCCN. The OLYM intertidal is the most biologically- and habitat-diverse park shoreline in the NCCN. The terrestrial portion of the coastal strip was added to OLYM in 1953, while the intertidal zone was added in 1986. Approximately 75% of this continuous stretch of coastline was designated wilderness by Congress in 1988 (Klinger et al. 2007b). In the summer of 1988, in response to concerns of oil spills and the need for adequate baseline information on intertidal communities, development of an OLYM intertidal monitoring program was initiated under contract with Dr. Megan Dethier of the University of Washington Friday Harbor Labs. Program development accelerated after the coastal oil spills of 1988 and 1991 (Dethier 1991). Dr. Dethier's program continued to refine sampling techniques in sand, cobble, and rocky habitats through 1996, when responsibility for the program passed to the NPS after hiring a staff intertidal biologist (Dethier 1995, 1997). Under NPS direction, the OLYM intertidal program continued development to the present, with program changes reflecting expanded monitoring goals (oil spill impact vs. multiple-stressors) and implementation of the NPS Inventory and Monitoring Program (NPS 2001). PISCO has also established four biodiversity monitoring sites within OLYM, three of which co-occur on beach segments with monitoring sites in this protocol.

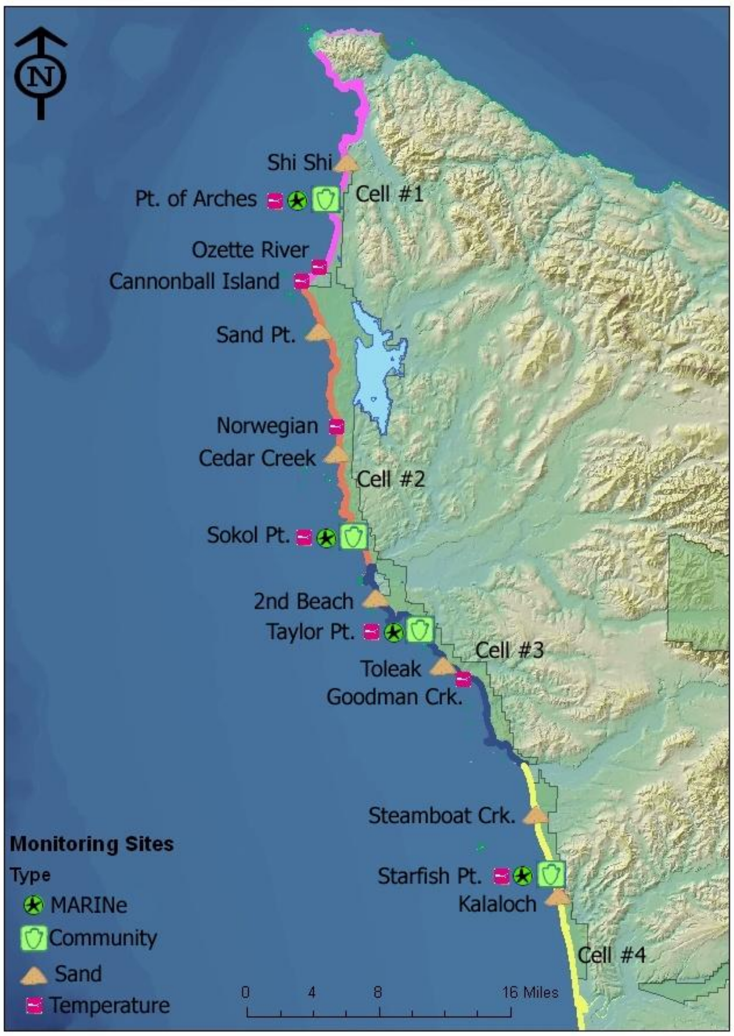

Figure 4. Site map of the coastal strip of Olympic National Park (OLYM). Monitoring sites are denoted by symbols identified in the legend. Where rock and temperature symbols are adjacent, temperature loggers are co-located on the same beach segments. Labeled nearshore cells characterized by temperature and salinity (Schoch 1999) are denoted by colored shoreline segments.

San Juan National Historical Park (SAJH)

SAJH, located on San Juan Island in the San Juan Archipelago in northern Puget Sound (Figure 5), was established in 1966 to commemorate the Pig War of 1859 and the joint occupation of the island by U.S. and British troops during the territorial dispute lasting from 1852-1872. The park consists of two units, English Camp with 1.7 miles of shoreline at the north end of the island within Garrison and Westcott Bays, and American Camp with 4.4 miles of shoreline at the south end of the island. The highly protected English Camp shoreline consists mainly of mud/silt habitat, along with a small amount of gravel beach and rocky shoreline. The more exposed American Camp shorelines are composed largely of mixed-coarse substrates (sand/gravel/cobble), with small areas of rocky and mud/silt shoreline (Klinger et al. 2006). A set of intertidal monitoring sites was established by Dr. Dethier in the early 1990's (Dethier 1993), however subsequent monitoring has not been maintained by the NPS.

Figure 5. Site map of San Juan Island National Historical Park (SAJH). Monitoring sites are denoted by symbols. Where rock and temperature symbols are adjacent, temperature loggers are co-located on the same beach segments.

Intertidal Monitoring Challenges in the NPS

A coordinated approach to intertidal monitoring across NPS marine parks under the NPS Inventory and Monitoring Program has been a challenge, due in part to the existence of legacy monitoring programs in parks with marine staff and the program network structure. NPS units differ historically in the attention that has been given to monitoring natural resources. Large parks like Channel Islands National Park (Richards and Davis 1988) and Olympic National Park (Dethier 1997) developed monitoring programs well before the establishment of the NPS Inventory and Monitoring Program in 2000, while smaller parks have not had the staff or resources to establish programs. Each of the 32 NPS networks started developing network-specific programs at different times, thus most networks have been at different stages of program development. The marine parks on the west coast of the continental US are located in four networks (Figure 6) and those in Alaska are in a fifth. In an effort to coordinate intertidal programs across these parks, a Marine Monitoring Workshop was held in Oakland, CA in April 2004 by NPS staff to assess program commonalities across this “phantom” network. A primary goal of the workshop was to assess whether any monitoring components or standard operating procedures (SOPs) could be implemented at each park that would allow for coast-wide comparisons. While the workshop did not result in a common methodology or even a common set of objectives for the phantom network, it did establish a foundation for coordination. Subsequently, the MARINe consortium’s core methods have emerged as a standardized set of SOPs that allow comparison across both the phantom network and additional non-NPS areas. The NCCN became a member of the MARINe consortium in 2008 and MARINe SOPs form the core rocky shoreline monitoring methods in this protocol (SOPs 1 and 2).

B. Rationale for Monitoring the Intertidal Zone in NCCN Parks

The intertidal zone occupies the overlap between terrestrial and nearshore marine ecosystems. As such, the processes and organisms there are susceptible to anthropogenic stressors from both land and sea. The NCCN intertidal zone is an extremely rich reservoir of biodiversity that is important both ecologically and culturally. These areas host the highest diversity of marine invertebrates and macroalgae on the west coast of North America. At OLYM alone, where no formal coastwide inventory has been conducted, over 350 species of invertebrates and macroalgae have been recorded. These biological communities serve a key functional role in the foodweb dynamics of the nearshore ecosystem, manifested through nutrient transport (Aquilina et al. 2009, Schoch et al. *in review*), and direct exchange of organisms between zones (Kozloff 1996). Most benthic invertebrates and macroalgae have pelagic life-stages that live in the nearshore coastal ocean and contribute to its highly productive foodweb. Intertidal organisms are relied upon by Native American communities for ceremonial and subsistence purposes, and the NPS has special trust responsibilities to protect these resources. The general American public also exploits intertidal resources and appreciates the intrinsic beauty and wilderness character of the intertidal zone. Intertidal monitoring has evolved over the past 20 years into a robust scientific field with sophisticated methodologies that are capable of detecting change in physical and biological characters at meaningful levels of resolution (Schmitt and Osenberg 1996, Murray et al. 2006).

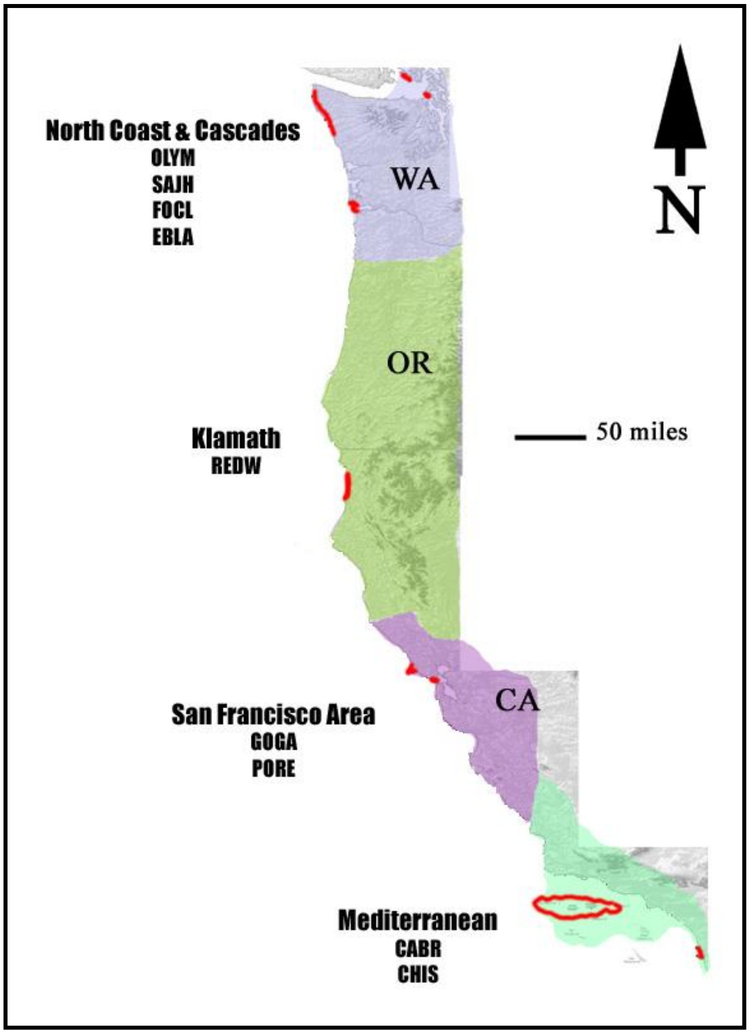

Figure 6. The “Phantom Network”: West coast marine NPS park units (in red) and their formal Inventory and Monitoring Network membership. Dispersing marine parks across different networks has frustrated a coordinated NPS marine monitoring approach.

Ultimately, the intertidal monitoring program outlined in this protocol will allow park managers to detect meaningful changes in key intertidal resources and a fundamental environmental factor (i.e. temperature) that profoundly influences them. Once detected, park managers can coordinate targeted research to identify causal factors. Park managers can also use monitoring results to consider and implement a range of management actions and adaptation strategies to address changes and their impacts on park resources and visitor use (Richardson and Loomis 2004, Parry et al. 2007). Management actions considered will necessarily depend upon the nature of causal factors and the magnitude and types of changes observed and expected. Some factors are within the NPS’s control (e.g. harvest, access issues), while others are outside of its control. In the latter case, park data may be useful to bolster evidence for a cause/change (e.g. climate change effects, commercial fishing impacts) that may ultimately be useful for altering behavior beyond park boundaries.

C. Measurable Objectives

Monitoring Priorities

From 2000-2003 a series of workshops occurred in each NCCN park to determine monitoring priorities within key network ecosystems through the identification and sorting of potential monitoring topics and indicators (Weber et al 2009). The marine ecosystem discussions in these workshops considered stressors and their ecosystem responses (Figure 2) to identify an array of potential monitoring topics of importance. These topics organized by category are:

- Organisms
  - Fish
  - Invertebrates and macroalgae
    - Target species
    - Communities
    - Surfgrass
    - Invasive species
- Habitat
  - Rocky shorelines
  - Sand beaches
  - Mixed-coarse beaches
  - Estuaries
  - Soft sediments
- Environmental
  - Temperature
  - Salinity
  - pH
  - Dissolved oxygen
  - Upwelling intensity
  - Chlorophyll-a concentration
  - Wave height
- Visitor Use
  - Trampling
  - Harvest

Further workshop discussions debated the feasibility and relative merits of these topics. These discussion results, in addition to other logistical and evolving fiscal limitations (discussed below in Chapter 2) necessarily limited the scope, objectives, number of sites, habitat types, and measurement parameters in the current NCCN Intertidal Monitoring Protocol.

Of the above topics, invertebrates and macroalgal (target species and communities) in rocky shoreline and sand beach habitats, in addition to intertidal temperature, were identified as priority NCCN monitoring topics. This prioritization was based on a combination of perceived resource value, logistical and budgetary feasibility, and the current state of scientific methodology. Emphasis was placed on topics that may provide early warning responses to the effects of global climate change and pollution, especially oil spills. The ability to assess changes in the vertical distribution of rocky intertidal organisms, a phenomenon predicted as a response to global climate change, has been a feature of OLYM legacy monitoring and is a high priority for OLYM management. This priority is addressed by SOP 3 that augments the MARINe Target Species monitoring (SOP 1).

Soft sediment, estuarine, and mixed-coarse (e.g. cobble, gravel) habits, in addition to surfgrass beds, intertidal fish assemblages, and lower elevation zone biotic communities of rocky platform and sand beach habitats are not considered here. Pilot MARINe surfgrass plots have been established at one site in OLYM in 2009, however these plots have not been formally incorporated into the current protocol due to logistical limitations. Surfgrass plots will have the highest priority when additional funding becomes available. While visitor impacts and the detection of invasive species are concerns to NCCN managers, this monitoring program is not specifically designed to address them. The effect of these stressors can be detected in our monitoring plots; however, separate more-elaborate monitoring programs outside of the scope of this protocol are required to adequately assess these stressors.

Monitoring Goal

The overarching goal of this monitoring protocol is to detect ecologically significant changes in key intertidal biota and regulating environmental factors in the major habitats of NCCN parks as indicators of ecosystem health and as an early warning of ecosystem impacts. Biotic trends can originate from impacts at a variety of levels within intertidal ecosystems, from those related to physiological processes (e.g. growth rate, reproductive potential), to direct mortality, to changes in ecological interactions between community constituents (e.g., competition, predation). The emergent properties of impacts at these levels are manifested as changes in species abundance, community composition, and elevational distribution shifts. These properties are considered as primary biotic indicators in this protocol.

Specific Monitoring Objectives

1) Characterize inter-annual natural variation in species abundance and community structure in rocky shoreline and sand beach intertidal habitats.

2) Characterize seasonal and inter-annual natural variation in intertidal temperature in distinct nearshore oceanographic areas in NCCN parks.

3) Detect trends in intertidal temperature and the species abundance and community structure of rocky shoreline and sand beach intertidal habitats.

4) Assess detected trends to formulate appropriate management actions or adaptation strategies, and where appropriate, to trigger targeted research to identify causal stressors.

5) Integrate with and contribute to the MARINe monitoring network to enable comparison of NCCN rocky target species data to other monitoring locations along the west coast of North America.

2. Sampling Design

A. Design Components

The sampling design proposed in this protocol consists of 3 components: 1) rocky shoreline monitoring; 2) sand beach community monitoring; and 3) intertidal temperature monitoring. Sand beach and rocky shoreline components focus on marine invertebrates and macroalgae (seaweeds) and do not address intertidal fish or highly mobile invertebrates (i.e. shore crabs, etc.). Spatial and temporal design details for each component are described below, while procedural details are found in the SOPs at the end of the protocol. Below is a brief description of each protocol component.

1. *Rocky Shoreline Monitoring* – Rocky shorelines are some of the most charismatic, diverse ecosystems in the world, and are a major habitat in NCCN parks. In OLYM, rocky shoreline occupies approximately 21% of the coastline. This habitat is susceptible to global climate change, oil spills, over-harvest, and trampling effects (Helmuth et al. 2006, Erickson et al. in press). Rocky monitoring has been established at 7 sites in the NCCN and follows MARINe consortium core protocols (Engle 2005, Miner et al. 2005, Becker 2006) augmented by additional plots (Community Rocky Shoreline) at OLYM. NCCN MARINe implementation slightly modifies standard MARINe methods (Engle 2005) to accommodate NCCN site requirements (i.e., wilderness designation) and priorities (i.e. incorporation of layering). These deviations do not affect data compatibility and are identified in SOPs 1 and 2. The MARINe core methods and the augmentation methods are defined as:

    a. ***MARINe Target Species*** monitoring at rocky sites focuses on barnacle, mussel, and seastar plots. Barnacle and mussel plots (SOP 1) use 5 replicate fixed photo plots to document changes in the abundance of target species. Seastar plots (SOP 2) use 3 fixed, irregularly shaped plots to determine seastar abundance. These plots are limited in their ability to track elevational shifts in species distributions, and rely upon site photos to assess such shifts.

    b. **Community Rocky Shoreline** monitoring methods augment the MARINe Target Species methods and are currently conducted only at OLYM. These Community plots focus on 10 m long band transects on sloped rock faces (30-45° slope) that constrain the mid- and high-intertidal zones (as characterized by the barnacle and mussel zonation bands) to combined widths less than 5 m. These areas expand the scale covered in the MARINe Target Species plots and explicitly track change in the vertical distribution of organisms by including an elevational gradient. Vertical change is a major prediction of climate change effect and is a high priority for OLYM management. These plots are sampled using point counts to estimate percent cover of sessile organisms, and quadrats to estimate abundance of weakly mobile organisms respectively.

2. *Sand Beach Community Monitoring* – Monitoring of invertebrates living in fine sand beaches that dissipate wave energy will be conducted at target parks with appropriate beaches. These beaches are highly productive and host relatively stable infaunal

communities, while exposed sand/gravel beaches tend to have depauperate, ephemeral communities (Brown and McLachlan 2002). Sand beaches are dominant habitats in the NCCN. For example, sand beaches make up 30% of the OLYM coastline. Sand beach infaunal communities are key resources to migrating birds, and play an important role in nutrient recycling in the nearshore ocean (Schoch et al., in review). Sand beaches and their infaunal communities are particularly susceptible to global climate change, shoreline modification, and oil spills (Brown and McLachlan 2002). In this protocol, three random transects are established annually on each target beach. Each vertical transect is 60 m long perpendicular to the beach starting at the recent high tide line. Sampling stations are spaced every 7.5 m along a transect, where four sediment cores are extracted and passed through a fine sieve to retain all infaunal organisms. All organisms will be counted and identified to the appropriate taxonomic level. The elevational profile of each transect is surveyed to verify the dissipative structure of beach faces, and sediment samples from each station are collected to determine and verify substrate composition.

3. *Intertidal Temperature* – A set of temperature dataloggers has been deployed in each of the target parks at the mid intertidal level to assess seasonal and inter-annual intertidal temperature trends. Data loggers continuously monitor temperature year-round at a 30-minute interval. Intertidal organisms are regularly bathed in seawater and exposed to air for extended periods of time. Temperatures experienced while both inundated and exposed can alter physiological rates and/or exceed physiological tolerances (Sanford 1999), thereby altering intertidal community structure through mortality or changed species interactions. The Pacific Northwest is particularly susceptible to climate-change temperature impacts that can alter community structure (Helmuth et al. 2002).

B. Rationale for Selecting This Sampling Design Over Others

Intertidal Monitoring Methodologies

Intertidal monitoring work on the Pacific coast of the United States began in the early 1980s focusing mainly on rocky intertidal shorelines. Since then several major programs have evolved, each with goals and objectives that have led to a variety of monitoring designs (Murray et al. 2006). Throughout their evolution, programs have wrestled with sampling design issues, such as plot replication, area of inference, taxonomic resolution, elevational extent, and the degree of emphasis on species-specific monitoring versus community-based monitoring. Species-specific monitoring was refined in southern California by the MARINe group (Engle et al. 2005, Miner et al. 2005) by targeting ecologically and commercially important species (mussels, barnacles, owl limpets, abalone) and zones, using small photo plots. This monitoring has since been augmented by the MARINe/ PISCO-California group through more comprehensive "Biodiversity" surveys of broader rocky communities in larger areas that capture elevational gradients and a high degree of taxonomic resolution (UC Santa Cruz 2006). This work requires a staff of highly trained taxonomic experts. Researchers in the Pacific Northwest, particularly Megan Dethier's work (Schoch and Dethier 1996, Dethier 1997) and PISCO-Oregon (Kavanaugh and Sohlstrom 2002, Russell et al. 2006) have focused on community characterization in band transects at different tidal elevations. While these band transects cover larger areas than the smaller MARINe photo plots, they also require greater taxonomic expertise and field time similar to the PISCO biodiversity plots. This protocol uses MARINe methods to monitor fixed plots of key target organisms (i.e., photoplots and seastar plots). The plots are augmented at OLYM by band transect plots (Community Rocky plots, SOP3) that cover the high- and mid-intertidal zones. These band transects are larger than the Dethier band transects (1-5 m wide vs. 30 cm) and are smaller than the PISCO biodiversity band transect plots (>30 m wide). This design enables the tracking of elevational shifts in species distributions, yet does not require the staffing level or taxonomic expertise required by the PISCO biodiversity protocol.

Sand beach monitoring has received less attention on the west coast, mainly at Channel Islands National Park (CHIS) and OLYM. The CHIS program used the methods of Dugan et al. (1990) to conduct periodic sampling from 1994-2004 (Richards 2004). These methods involved extracting sand cores from several beach elevations to determine species composition and abundance, and are similar to those developed by Dethier (1997) for OLYM. Further refinement of these methods is detailed in SOP 4. In other coastal regions of the world substantial development of sand beach monitoring methods have been developed that are similar to those of Dethier (1997; also see Jaramillo et al. 1995, Defeo and Rueda 2002, Schoeman et al. 2003).

Mixed-coarse (cobble) habitats are common northwest coastal habitats that have received little monitoring attention. Cobble habitats are composed of rocks of varying size with interstitial sand and gravel that forms a complex shifting mosaic of rubble and pools. Diversity can vary greatly depending upon the degree of exposure to heavy surf. Areas protected by offshore islands and reefs can be highly diverse, with encrusting organisms on all rock surfaces and infaunal organisms in interstitial sediments (Dethier 1995). More exposed beaches, however, can have markedly reduced diversity due to high levels of disturbance (Boyd and DeMartini 1977). While cobble habitats are important reservoirs of diversity and are also areas of oil retention after spills (Jordan and Payne 1980), these areas are problematic to sample. Methods for sampling sides of cobbles, under cobbles, and interstitial sediment infauna have not been developed, yet these are species rich areas. Complexity of both habitat and species diversity makes it difficult to train seasonal staff, and the variable, slippery substrate presents a safety hazard to staff. At OLYM, cobble habitats were monitored consistently from 1996-2002 under methods devised by Dethier (1997) that focused on encrusting organisms on the exposed surfaces of cobble substrates. This monitoring was discontinued in 2003 to focus upon development and sampling of sand beach and rocky shoreline monitoring components.

Intertidal Monitoring Challenges

The intertidal zone is an incredibly productive and diverse marine area that is important ecologically, culturally, and economically, yet its complexity presents daunting challenges to ecologists attempting to monitor temporal trends. This complexity is a function of the alternating aquatic/terrestrial environment produced by tides, along with the elevational bands of organisms that result from environmental gradients, physiological tolerances, and competitive and predatory interactions. Intertidal zonation is most apparent on rocky shorelines (Lewis 1964, Harley 2007) but is also present in sand beaches (McLachlan and Jaramillo 1995). Particular challenges that influence intertidal monitoring include:

1. *Exposure Time*: The intertidal zone is flooded and drained twice per day, the timing and magnitude of each is a function of the tidal cycle as influenced by the moon and sun. The amount of time available to work at lower tidal elevations is much more limited relative to the amount of time available in the mid to upper elevations. For example, the lower

intertidal zone (mean lower low water) is submerged 90% of the time, while the mid zone (mean sea level) is submerged 50% of the time, and the high zone (mean higher high water) is submerged 10% of the time (Schoch et al. 2006). This protocol focuses on the middle and upper tidal elevations, from mid to high zone, to increase the amount of time available to conduct fieldwork and to ensure staff safety.

2. *Finite Tide Series*: Low tide series – sets of days where the daily low tides are particularly low relative to the mean lower low water (the "zero" elevation) – occur approximately every other week. Daylight negative low tide series, where daily low tides fall below the mean lower low water during daylight hours, occur from April-September in the Pacific Northwest. Night-time negative low tides occur during stormy winter months, and present an unacceptable safety hazard for field crews, particularly on the remote, wave-swept outer coast. There are approximately 11 daylight negatives tide series available for field work each year.

3. *Taxonomic Complexity and Staffing*: Biotic diversity increases at lower tidal elevations. Particularly on rocky shorelines, sampling to the species level requires a high level of taxonomic expertise not frequently found in the pool of seasonal technicians available each summer. Retention of temporary staff that can be highly trained beyond a few seasons is rare. However, seasonal technicians can be and have been trained to reliably identify major species groups and all sand beach taxa normally encountered. Higher taxonomic categories and readily identifiable taxa have been demonstrated to be useful in the detection of changes in community structure over time (Dethier and Schoch 2006). This protocol constrains taxonomic resolution and the elevational coverage (mid to upper zones) to ensure sampling feasibility.

4. *Fiscal Limitations*: The NCCN Intertidal Protocol competes for limited funding with 13 other vital sign protocols that span a range of disciplines across the 8 NCCN parks (Figure 7). This protocol is in the highest priority group (Core 1) and will be funded annually at approximately $32,000. This funding level necessarily constrains the number of sites/plot that can be monitored. However the cost for monitoring the 15 rocky and sand beach sites and 14 temperature sites in the NCCN compares favorably with the costs of similar programs. For example, the Redwood National Park intertidal protocol (Ammann and Raimondi 2008) monitors three MARINe sites at a cost of $25,000. Unfortunately, reliance on volunteers to augment field activities is not feasible. As opposed to many Californian national park units, the wilderness OLYM coast is 1-3 hrs from populated areas with difficult access to field sites, making recruitment of dependable volunteers the exception rather than the rule.

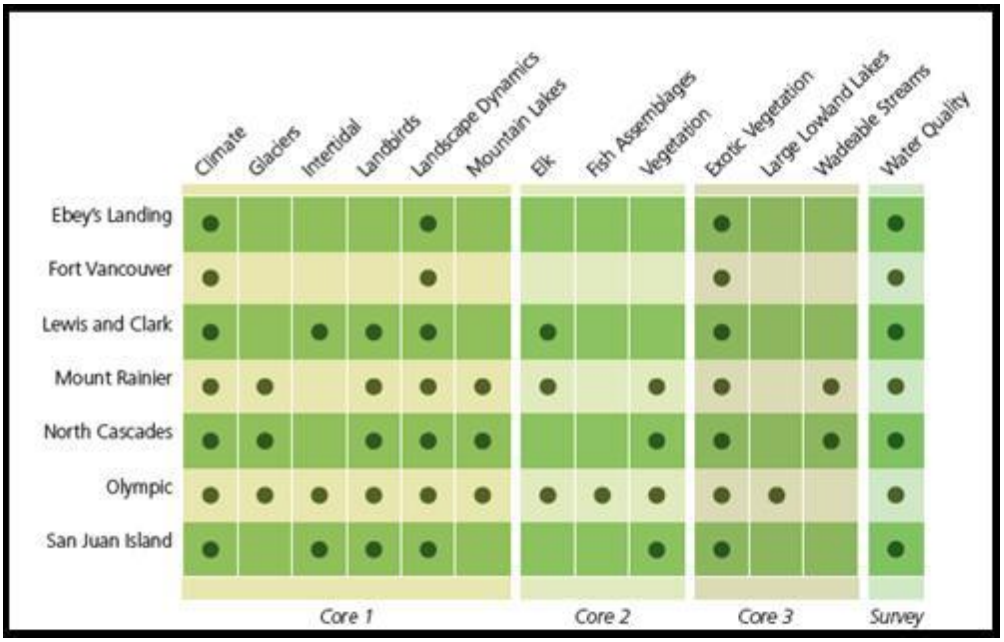

Figure 7. Prioritized NCCN monitoring protocols and parks for which their implementation is intended. Core 1 protocols are the highest priority and are guaranteed consistent annual funding.

Given the challenges outlined above, the succinct rationale for each monitoring component is as follows:

1. *MARINe Target Species Rocky Monitoring*: SOP 1 presents the core sampling design of the MARINe monitoring consortium (Engle 2005) and places changes in key NCCN rocky shoreline species abundances into the context of comparative change in similar habitats in the MARINe network at over 80 sites across the West Coast of the United States. This MARINe methodology uses permanent photoplots to target species aggregations. Other elements of change, such as elevational shifts in mid and high intertidal zone communities are considered in the Community Rocky monitoring component below.

2. *Community Rocky Shoreline Monitoring*: This OLYM-specific component (SOP 3) uses permanent adaptive belt transects to detect trends in community composition, species abundance, and the distribution of organisms across an elevational gradient (mid- to high-intertidal), using a sampling methodology consistent with accepted monitoring practices (Dethier 1997, Murray et al. 2006, UC Santa Cruz 2006).

3. *Sand Beach Monitoring*: The vertical transect coring approach (SOP 4) is a modification of the design developed by Dethier (1997) that has been conducted in OLYM since 1997. This methodology is consistent with what are now standard methods in sampling sand beach infauna (Schoeman et al. 2003).

4. *Intertidal Temperature*: We use standard methodologies used to measure intertidal temperature by the research and monitoring communities (SOP 1; Sanford 1999, Menge et al. 2008).

C. Site Selection

Criteria for Site Selection

The intertidal zones of NCCN marine parks are bathed in waters that differ in their physical and chemical characteristics (i.e. salinity, temperature) resulting from differing landscape position and oceanographic processes. These physical/chemical differences can affect community composition and changes in species distribution and abundance. Monitoring sites for each component have been selected from within areas (nearshore cells) identified as coherent water masses. Within OLYM, Schoch (1999) identified 4 distinct nearshore cells based on salinity and temperature (Figure 4). In SAJH, the American Camp unit shoreline exposed to the Strait of Juan de Fuca and the protected English Camp shorelines within Garrison and Wescott Bays are assumed to be distinct nearshore cells (Figure 5). At LEWI, the Sunset Beach and Ecola State Park units are assumed to be in the same nearshore cell (Figure 3). Sites have been selected at OLYM, LEWI, and SAJH based on the criteria outlined below and the total number of sites is summarized by park in Table 1.

General criteria for site selection are consistent with the MARINe criteria (Engle 2005). These general criteria explicitly consider:

- Areas previously surveyed or monitored that provide historical data
- Un-surveyed areas representing major data gaps
- Areas of concern with regard to human impacts, including oil spills
- Areas with relatively pristine habitats
- Areas with species assemblages and ecological conditions representative of the NCCN coast
- Areas that provide habitat for sensitive or rare intertidal species
- Areas with optimum conditions for long-term monitoring:
    - Reasonable and safe site access
    - Adequate substrate for permanent plots for rocky monitoring
    - Sufficient abundance of key species for target species monitoring
    - Minimal disturbance to sensitive resources such nesting seabirds and marine mammal haul-outs

Specific criteria for each monitoring component include:

- *MARINe Rocky Target Species Monitoring:* Appropriate sites occur on rocky platform beach segments with plot locations chosen in areas where assemblages are dominated by core target species. For NCCN implementation, core target species are barnacles and mussels. MARINe monitoring occurs at OLYM, LEWI, and SAJH.

- *MARINe Seastar Monitoring:* These judgment plots occur on rocky platforms and are selected based on the following considerations: 1) High initial *Pisaster* densities that suggest preferred habitat. 2) Presence of substrate characteristics (e.g. landmarks, substrate composition that retains bolts) that facilitate relocation of plots annually. 3) Location on beach segments adjacent to but not overlapping other monitoring sites.

- *Community Rocky Shoreline Monitoring:* Appropriate sites occur on rocky platform beach segments, with plot locations chosen on sloped faces (30-45°) with distinct zonal bands of barnacles and mussels. Sloped faces concentrate bands of high and mid elevation benthic organisms into distinct zones less than a combined width of 5 m. This monitoring component is implemented only at OLYM.

- *Sand Beach Monitoring:* Appropriate sites for this component include dissipative open coast beaches that are made up of fine-grained particles. Beaches with coarse grained particles including a high level of gravel are usually reflective beaches that are inappropriate as they contain low densities of only a few species and require a different set of methodologies (McLachlan 1990, McLachlan and Jaramillo 1995). These latter beaches are the only type found in SAJH. Sand Beach Monitoring is conducted in OLYM.

- *Temperature Monitoring:* Intertidal dataloggers require stable rocky substrates for permanent placement. Candidate sites must have appropriate substrate in the mid-intertidal zone (+2.5 ft elevation) and must not have adjacent highly mobile cobble or sand-gravel substrates that can damage dataloggers due to wave action.

Procedures for Selecting Sampling Locations

Shoreline habitat datasets (Schoch 1999, Bloch 2001) were used to determine the number of appropriate beach segments within each nearshore cell in OLYM and SAJH. All candidate beach segments were field-verified to ensure suitability.

- *Rocky Intertidal Monitoring:* A single rocky beach segment was chosen at random from the list of potential beach segments within each nearshore cell. In each target beach segment, MARINe plots (Target Species and Seastar) and a Community Monitoring plot were selected based on the above criteria. MARINe and Community plots are co-located near each other, but do not spatially overlap. In LEWI, the MARINe site has been previously selected by the California-based MARINe group using similar methods described by Engle (2005).

- *Sand Beach Monitoring Component:* Two sand beach segments were chosen at random from a list of potential beach segments within each nearshore cell, with the exception of nearshore cell #1 in OLYM and Sunset Beach in LEWI. In both these nearshore cells, only one sand beach is present and was chosen.

- *Temperature Component:* Two dataloggers have been installed in each nearshore cell based on the availability of appropriate rocky habitat. Dataloggers have been installed on separate rocky headlands to better characterize intertidal temperature conditions in a nearshore cell. Each beach segment selected for Rocky Intertidal monitoring has a co-located temperature datalogger.

D. Sampling Frequency and Replication

The number of monitoring sites, plot types and replicates for each monitoring component in the NCCN are summarized in Tables 1 and 2. Descriptions of the sampling frequency and replication for each component are:

- *MARINe Rocky Target Species and Seastar Monitoring:* One MARINe site is monitored in each OLYM nearshore cell and SAJH unit (English and American Camp). One MARINe site is monitored at LEWI. Monitoring occurs during summer low tide series from June-August. Each site is usually sampled by a team of 2-3 staff on a single low tide event less than -1.0 ft.

- *Community Rocky Shoreline Monitoring:* One site in each OLYM nearshore cell is monitored annually during summer low tides series from June-August. Each site is usually sampled by a team of 2-3 staff on a single low tide event less than -1.0 ft.

- *Sand Beach Monitoring:* Sand beaches are monitored annually during summer low tide series from June-August. Two beaches are sampled in each OLYM nearshore cell, except for cell #1 that contains only one sand beach (Shi Shi). On each sampled beach, 3 random transects are sampled. Random transects are determined based on drawing random distances from the start of each beach segment. Each site with three transects is usually sampled by a team of 4-5 staff on a single low tide less than -1.0 ft.

- *Temperature Monitoring:* Dataloggers are programmed to record temperature every 30 minutes and are downloaded and maintained annually during the summer low tide series. Two dataloggers will be installed in each OLYM nearshore cell (defined above) with one LEWI and two in SAJH.

Table 1. Number of monitoring sites for each monitoring component in NCCN parks.

	Number of sites per park		
Component	**OLYM**	**LEWI**	**SAJH**
Rocky Shoreline	4	1	2
Sand Beach	7	0	0
Intertidal Temperature	8	1	2

Table 2. Number of replicates for each component. * Rocky Community and Sand Beach plots are only conducted at OLYM. ** Rocky sites are co-located with temperature datalogger sites, which are replicated at the nearshore cell level.

Component	Plot Type	Replicates/site
Rocky shoreline	MARINe	
	Barnacle	5
	Mussel	5
	Seastar	3
	Community *	1
Sand beach	Sand transect*	3
Temperature	Datalogger	2**

E. Level of Change That Can Be Detected

The primary goal of this NCCN protocol is to determine the limits of natural variation in component parameters (temperature, species abundance, community composition) and to detect ecologically significant trends in these data. Power analyses of historical data using similar (but in most cases not the same) design and sampling procedures allows estimation of one's ability to detect change. Power analyses have been conducted on data sets that provide insight into the level of change that can be detected in the Rocky Platform and Sand Beach Monitoring components.

Power analyses for the MARINe Target Species methods have been conducted on data from an 11-year dataset from southern and central California using a Before-After design (Minchinton and Raimondi 2005). These analyses suggest a capability to detect a 50% change in abundance with 80% power. While these analyses are based on data from a different biogeography region where population dynamics differ due to oceanographic processes (Connolly et al. 2001, Broitman et al. 2008), comparable power should be expected from data derived from NCCN sites.

In 2005, West Inc., a statistical consulting firm that has conducted numerous analyses for NCCN programs, conducted a power analysis via Monte Carlo simulations using historical OLYM intertidal data from rocky shoreline and sand beach habitats (Nielson and McDonald 2005). All data were collected between 1997-2004 following the design and methods of Dethier (1997). For both habitats, the power analyses suggested that one might detect a 10-15% annual change in abundance after ten years of monitoring at the 80% power level based on an annual sampling regime (Figure 8).

The historical Dethier/OLYM rocky monitoring is similar to the Community Rocky Shoreline methods in SOP 3. Both are 10 m belt transects with 10 quadrats and 100 point counts. The major design difference is in belt width, with 30 cm for the Dethier/OLYM design compared with 1-5 m wide belts for the current design. Given these belt width differences, it is likely that data from the rocky Community plots will have higher variability, and the resulting power to detect trends will be lower than that determined for the Dethier/OLYM design. The rocky Community belt transects are located on relatively steep slopes that should concentrate organismal banding, thereby reducing the variability one might expect in high- and mid-elevational zones on broad, mildly-sloping platforms.

The Dethier/OLYM sand beach methodology is very similar to the proposed Sand Beach Monitoring component methods. The noteworthy differences in the current design are an increase in the number of transects sampled per beach segment (from one to three), and the restriction of sampling the top 60 m of beach (the high- and mid-zone) for the Sand Beach component. Given the increase in replication, the resultant power of the Sand Beach component should be similar to that estimated for the Dethier design.

The results of the above power analyses all fall within levels that are reasonable goals for monitoring studies (Fairweather 1991). Regardless, as part of the 5 year analysis report, new power analyses will be conducted from NCCN data for each monitoring component to re-evaluate their abilities to detect trends.

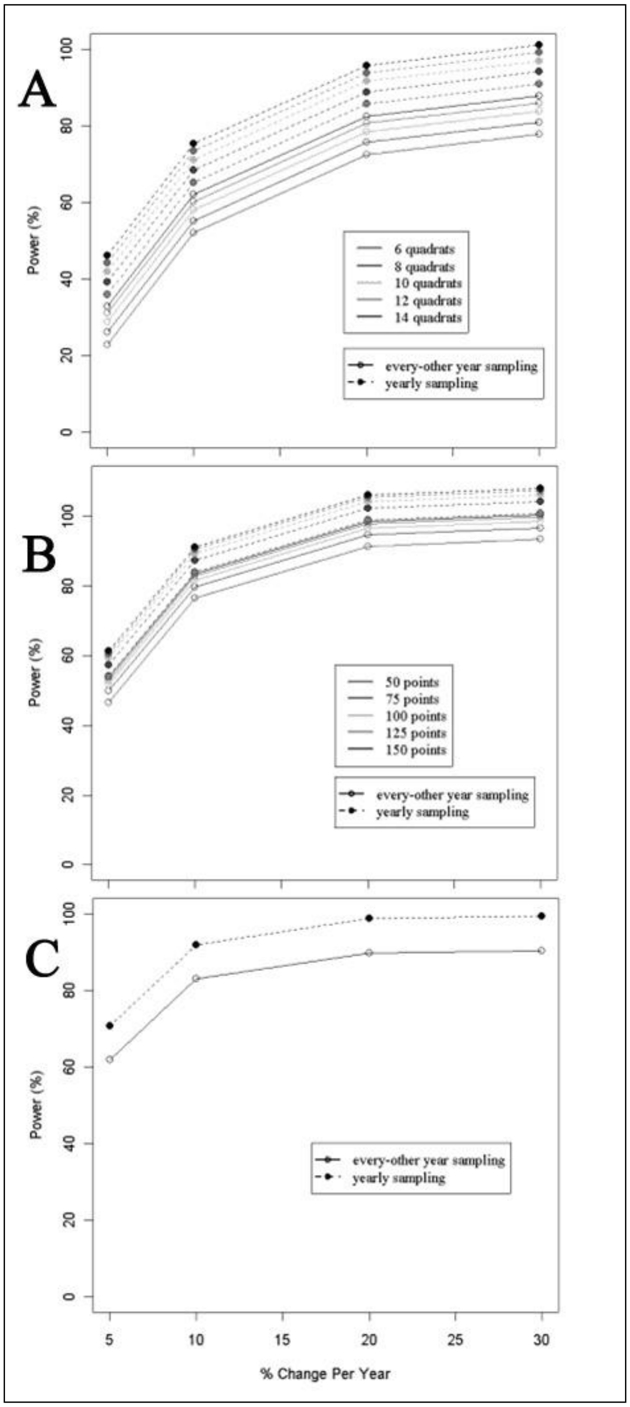

Figure 8. Results of analysis of variance on simulation results. Average power to detect positive or negative trends (< =0.10) after 10 years of monitoring as a function of sub-sample size and site visitation strategy. A) Abundance of weakly mobile species at rocky sites. B) Percent cover of sessile organisms at rocky sites. C) Abundance of focal species at sandy sites (average differences in power for different sub-sample sizes (# cores/elevation/transect) were extremely small and are not shown). Data are from Nielson and MacDonald (2005).

3. Field Methods

A. Field Season Preparations and Equipment Setup

Prior to the beginning of each field season each of the following activities will occur consistent with the schedule outlined in **Appendix 1: Yearly Project Task List**.

- At the end of the prior field season, all field and laboratory equipment will be inventoried and checked for functionality.
- Prior to the field season, all field and laboratory equipment will be inventoried and checked to ensure proper working order according to particular equipment maintenance schedules.
- New supplies and equipment will be purchased.
- Site directions and plot locations will be secured.
- From mid-March through April all field technicians will undergo training on all procedures, including field and lab based training.

B. Sequence of Events During the Field Season

Note: Refer to **Appendix 1: Yearly Project Task List** for a schedule of annual tasks.

The field season for intertidal work in the NCCN occurs from May through the end of August, when the lowest daylight tides of the year occur. Particularly in OLYM, the outer coast is very dangerous during the nighttime low tides of the fall, winter and spring, thus routine fieldwork during that time period does not occur. The annual cycle for program activities appears in Table 3. The hiring and training process occurs in the spring so that fieldwork can begin as soon as appropriate low daylight tides begin in early May. Field sites are monitored during appropriate tides from May through early September, with data entry and quality assurance procedures conducted by staff during unfavorable tide periods during the field season.

Table 3. Annual sequence of intertidal monitoring events**.**

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Hiring												
Training												
Data Collection												
Data Entry												
Quality Review												
Reporting												
Records Mgmt												

C. Permitting and Compliance

At OLYM, approximately 75% of the coastline is within congressionally-designated wilderness. The methods and procedures outlined in this protocol have undergone a minimum requirement analysis by the OLYM Wilderness Committee and have been deemed acceptable.

All procedures associated with this protocol fall under a NEPA categorical exclusion for monitoring in parks. Prior to implementation, the park compliance officer will be consulted to ensure that all monitoring activities fall under the categorical exclusion.

D. Field Methods and Procedures

Field activities consist of summertime sampling activities coordinated with low tides. The design of these activities is outlined in **Chapter 2: Sampling Design**. Specific methods for each field activity, including example field forms, quality assurance and quality control (QA/QC) procedures, are found in the Standard Operating Procedures and Appendices.

4. Data Management, Analysis and Reporting

This chapter describes the procedures for data management, analysis, and report development. Additional details and context for this chapter are provided in the NCCN Data Management Plan (Boetsch et al. 2009), which describes the overall information management strategy for the network. The NCCN website (http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm) also contains guidance documents on various information management topics (e.g., report development, GIS development, GPS use).

A. Project Information Management Overview

Project information management may be best understood as an ongoing or cyclic process, as shown in Figure 9. Specific yearly information management tasks for this project and their timing are described in **Appendix 1: Yearly Project Task List**. Readers may also refer to each respective chapter section for additional guidance and instructions.

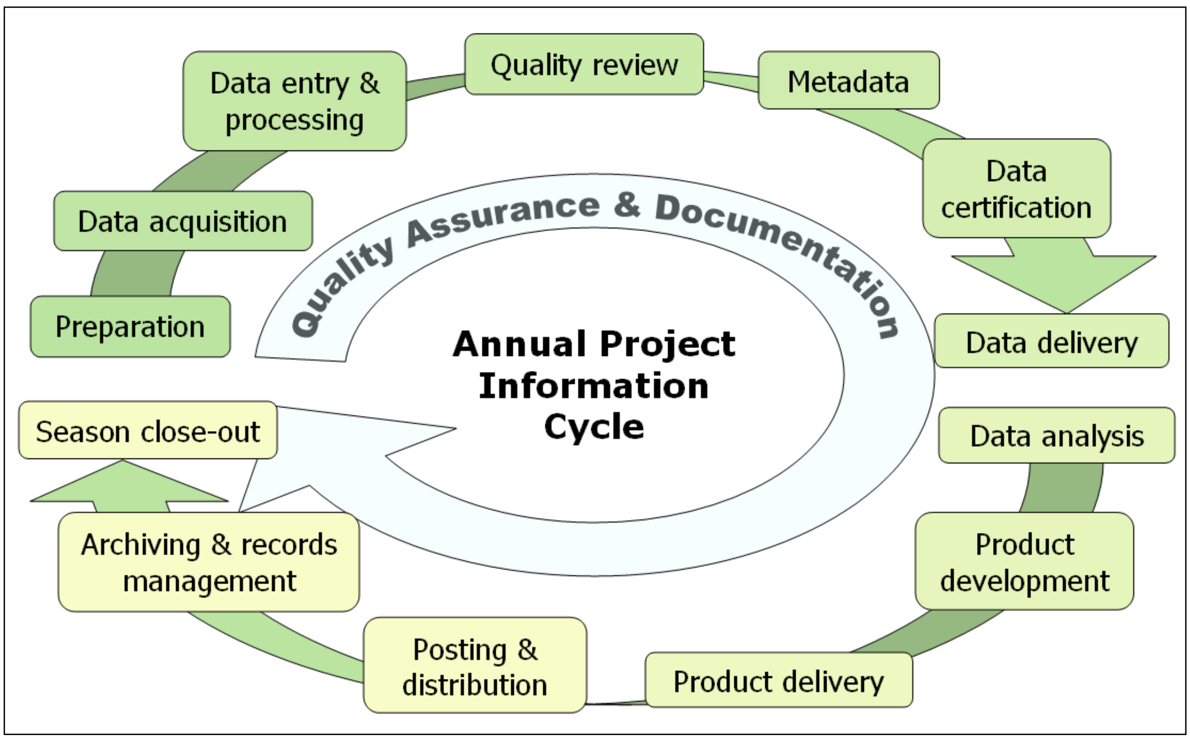

Figure 9. Idealized flow diagram of the cyclical stages of project information management, from pre-season preparation to season close-out. Note that quality assurance and documentation are thematic and not limited to any particular stage.

The stages of this cycle are described in greater depth in later sections of this chapter, but can be briefly summarized as follows:

- *Preparation* – Training, logistics planning, print forms and maps
- *Data acquisition* – Field trips to acquire data
- *Data entry & processing* – Data entry and database uploads, GPS data processing, etc.

- *Quality review* – Data are reviewed for structural integrity, completeness and logical consistency
- *Metadata* – Documentation of the year's data collection and results of the quality review
- *Data certification* – Data are certified as complete for the period of record
- *Data delivery* – Certified data and metadata are delivered for archiving
- *Data analysis* – Data are summarized and analyzed
- *Product development* – Reports, maps, and other products are developed
- *Product delivery* – Deliver reports and other products for posting and archiving
- *Posting & distribution* – Distribute products as planned and/or post to NPS clearinghouses
- *Archiving & records management* – Review analog and digital files for retention (or destruction) according to NPS Director's Order 19. Retained files are renamed and stored as needed.
- *Season close-out* – Review and document needed improvements to project procedures or infrastructure, complete administrative reports, and develop work plans for the coming season

B. Pre-season Preparations for Information Management

Project Workspace Setup
A section of the networked file server at OLYM is reserved for this project, and access privileges are established so that project staff members have access to needed files within this workspace. Prior to each season, the Project Lead should make sure that network accounts are established for each new staff member, and that the Data Manager is notified to ensure access to the project workspace and databases. Workspace structure, naming conventions, and additional details are provided in **SOP 6: Project Workspace and Records Management**.

Project Database Application
Prior to the field season, the Data Manager will update the project database application as needed to ensure proper access on the part of the project staff. Refer to **Section 4C, Overview of Database Design** for additional information about the database design and implementation strategy.

C. Overview of Database Design
We maintain a customized relational database application to store and manipulate the data associated with this project. The design of this database is consistent with NPS I&M and NCCN standards. The Data Manager is responsible for development and maintenance of the database, including customization of data summarization and export routines.

The project database is divided into two components – one for storing data in a series of related tables composed of fields and records (i.e., the "back-end database"), and another that acts as a portal or user interface through which data may be entered, viewed, edited, error-checked, summarized and exported (i.e., the "front-end application"). By splitting the database into front- and back-end components, multiple users may interact with the data simultaneously, and user interface updates can be implemented without service disruptions.

The back-end database schema (tables, fields and relationships) is documented in **Appendix 2: Database Documentation**. The back-end database is implemented in Microsoft SQL Server to take advantage of the automated backup and transaction logging capabilities of this enterprise database software.

The front-end is implemented in Microsoft Access. It contains the forms, queries, and formatted report objects for interacting with the data in the back-end. Its features and functionality are customized using Visual Basic for Applications (VBA) programming code. The application has separate forms for data entry that mirror the layout of hard-copy field forms used during data collection. There are also forms for browsing and editing data, for completing the annual quality review, and for summarizing and exporting data to other software (e.g., for analysis and graphics production).

D. Data Entry and Processing

During the field season, the project crew will be provided with a copy of the project database front-end, through which they enter, process, and quality-check data for the current season.

Technicians should enter data as soon as possible after each field trip in order to keep current with data entry tasks, and to identify any errors or problems as close to the time of data collection as possible. The front-end database application is found in the project workspace. For enhanced performance, it is recommended that users copy the front-end onto their workstation hard drives and open it there. This front-end copy may be considered "disposable" because it does not contain any data, but rather acts as a pointer to the data that reside in the back-end database. Whenever updates to the front-end application are made available by the Data Manager, an updated front-end should be copied from the project workspace to the workstation hard drive.

Each data entry form is patterned after the layout of the corresponding field form, and has built-in quality assurance components such as pick lists and validation rules to test for missing data or illogical combinations. Although the database permits users to view the raw data tables and other database objects, users are strongly encouraged to use only these pre-built forms as a way of ensuring maximum data quality.

Regular Data Backups

Automatic database backups are scheduled in the SQL Server database management system to help prevent data loss in case of user error, drive failure, or database file corruption. Full backups are scheduled on a weekly basis, with daily transactional backups to enable restore operations to a point in time within a moving 8-week window. Weekly backups and transaction files are retained for 8 weeks to conserve drive space. Full monthly backups are stored for at least one year after data have been certified. Snapshot backup copies of certified data, made at the time of certification, are retained indefinitely.

Data Verification

As data are being entered, the person doing the data entry should visually review them to make sure that the data on screen match the field forms. This should be done for each record prior to moving to the next form for data entry. At regular intervals and at the end of the field season the Field Lead should inspect the data being entered to check for completeness and perhaps identify avoidable errors. The Field Lead may also periodically run the Quality Assurance Tools that are built into the front-end database application to check for logical inconsistencies and data outliers (this step is described in greater detail in **Section 4E, Data Quality Review** and also in **SOP 8: Data Quality Assurance, Review and Certification)**.

Field Form Handling Procedures
As field data forms are part of the permanent record for project data, they should be handled in a way that preserves their future interpretability and information content. If changes to data on the forms need to be made subsequent to data collection, the original values should not be erased or otherwise rendered illegible. Instead, changes should be made as follows:

- Draw a horizontal line through the original value, and write the new value adjacent to the original value with the date and initials of the person making the change.
- All corrections should be accompanied by a written explanation in the appropriate notes section on the field form. These notes should also be dated and initialed.
- If possible, edits and revisions should be made in a different color ink to make it easier for subsequent viewers to be able to retrace the edit history.
- Edits should be made on the original field forms and on any photocopied forms.

These procedures should be followed throughout data entry and data revision. On an annual basis, data sheets are to be scanned as PDF documents and archived (see the product delivery specifications in **SOP 10: Product Delivery, Posting and Distribution**). The PDF files may then serve as a convenient digital reference of the original if needed.

Image Handling Procedures
This section covers photographic images collected by project staff or volunteers during the course of conducting project-related activities. Images that are acquired by other means – e.g., downloaded from a website or those taken by a cooperating researcher – are not project records and should be filed and named in such a way that they will not be confused with project records.

Care should be taken to distinguish data photographs from incidental or opportunistic photographs taken by project staff. Data photographs are those taken for at least one of the following reasons:

- To document a particular feature or perspective for the purpose of site relocation
- To capture site characteristics and possibly to document gross structural changes over time
- To document a species detection that is also recorded in the data

Data photographs are often linked to specific records within the database, and are stored in a manner that permits the preservation of those database links. Other photographs – e.g., of field crew members at work, or photographs showing the morphology or behavior of certain intertidal species – may also be retained but are not necessarily linked with database records.

Refer to **SOP 7: Managing Photographic Images** for details on how to handle and manage image files.

E. Data Quality Review

After the data have been entered and processed, they need to be reviewed by the Project Lead for structural integrity, completeness and logical consistency. The front-end database application facilitates this process by showing the results of pre-built queries that check for data integrity, data outliers and missing values, and illogical values. The user may then fix these problems and document the fixes. Not all errors and inconsistencies can be fixed, in which case a description of the resulting errors and why edits were not made is then documented and included in the metadata and certification report (see **Sections 4F, Metadata Procedures** and **4G, Data Certification and Delivery**).

Data Edits After Certification

Due to the high volume of data changes and/or corrections during data entry, it is not efficient to log all changes until after data are reviewed and certified. Prior to certification, daily backups of the database provide a crude means of restoring data to the previous day's state. After certification, all edits to certified records are tracked in an edit log (refer to **Appendix 2: Database Documentation**) so that future data users will be aware of changes made after certification. In case future users need to restore data to the certified version, we also retain a separate, read-only copy of the original, certified data for each year in the project workspace.

Geospatial Data

The Project Lead and GIS Specialist may work together to review the surveyed coordinates and other geospatial data for accuracy. The purpose of this joint review is to make sure that geospatial data are complete and reasonably accurate, and also to determine which coordinates will be used for subsequent mapping and field work.

F. Metadata Procedures

Data documentation is a critical step toward ensuring that data sets are usable for their intended purposes well into the future. This involves the development of metadata, which can be defined as structured information about the content, quality, condition and other characteristics of a given data set. Additionally, metadata provide the means to catalog and search among data sets, thus making them available to a broad range of potential data users. Metadata for all NCCN monitoring data will conform to Federal Geographic Data Committee (FGDC) guidelines and will contain all components of supporting information such that the data may be confidently manipulated, analyzed and synthesized.

At the conclusion of the field season (according to the schedule in **Appendix 1: Yearly Project Task List**), the Project Lead will be responsible for providing a completed, up-to-date metadata interview form to the Data Manager. The Data Manager and GIS Specialist will facilitate metadata development by consulting on the use of the metadata interview form, by creating and parsing metadata records from the information in the interview form, and by posting such records to national clearinghouses.

An up-to-date metadata record is a required deliverable that should accompany each season's certified data. For long-term projects such as this one, metadata creation is most time consuming the first time it is developed – after which most information remains static from one year to the next. Metadata records in subsequent years then only need to be updated to reflect changes in contact information and taxonomic conventions, to include recent publications, to update data disposition and quality descriptions, and to describe any changes in collection methods, analysis approaches or quality assurance for the project.

Specific procedures for creating, parsing and posting the metadata record are provided in NCCN Metadata Development Guidelines (North Coast and Cascades Network—National Park Service, 2007). General procedures are as follows:

1. After the annual data quality review has been performed and the data are ready for certification, the Project Lead (or a designee) updates the metadata interview form.
    a. The metadata interview form greatly facilitates metadata creation by structuring the required information into a logical arrangement of 15 primary questions, many with additional sub-questions.
    b. The first year, a new copy of the NCCN Metadata Interview form (available at: http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm) should be downloaded. Otherwise the form from the previous year can be used as a starting point, in which case the Track Changes tool in Microsoft Word should be activated in order to make edits obvious to the person who will be updating the XML record.
    c. Complete the metadata interview form and maintain it in the project workspace. Much of the interview form can be filled out by cutting and pasting material from other documents (e.g., reports, protocol narrative sections, and SOPs).
    d. The Data Manager can help answer questions about the metadata interview form.
2. Deliver the completed interview form to the Data Manager according to the product delivery instructions in **SOP 10: Product Delivery, Posting and Distribution**.
3. The Data Manager (or GIS Specialist for spatial data) will then extract the information from the interview form and use it to create and update an FGDC- and NPS-compliant metadata record in XML format. Specific guidance for creating the XML record is contained in NCCN Metadata Development Guidelines (North Coast and Cascades Network—National Park Service, 2007).
4. The Data Manager will post the record and certified data to the NPS Data Store, and maintain a local copy of the XML file for subsequent updates.
5. The Project Lead should update the metadata interview content as changes to the protocol are made, and each year as additional data are accumulated.

G. Data Certification and Delivery

Data certification is a benchmark in the project information management process that indicates that: 1) the data are complete for the period of record; 2) they have undergone and passed the quality assurance checks (**Section 4E, Data Quality Review**); and 3) they are appropriately documented and in a condition for archiving, posting and distribution as appropriate. Certification is not intended to imply that the data are completely free of errors or inconsistencies that may or may not have been detected during quality assurance reviews.

To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. The Project Lead is the primary person responsible for completing an NCCN Project Data Certification Form, available at: http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm. This form should be submitted with the certified data according to the timeline in **Appendix 1: Yearly Project Task**

List. Refer to **SOP 8: Data Entry, Quality Assurance, Review and Certification** and the delivery specifications in **SOP 10: Product Delivery, Posting and Distribution** for specific instructions.

H. Data Analysis

After data for the current season have been certified, data analysis and report development may proceed. Routine data summaries, specific analysis methods to detect change, and methods for long-term trends are described in **SOP 9: Data Analysis**. The timing of analysis tasks and the schedule for deliverables are detailed in **Appendix 1: Yearly Project Task List**.

I. Reporting and Product Development

Report Content

We will produce an annual summary report, with a more detailed report produced every 5 years. The annual report shall contain:

- List of project personnel and their roles.
- List of project components completed (MARINe Target Species, MARINe Seastar, Community Rocky Platform, Sand Beach and Intertidal Temperature Monitoring).
- List of transects/plots/photoplots completed during the current year.
- Provide a summary history of the number of transects/plots/photoplots completed during each year of the study (enumerated by project component and park).
- List of all intertidal species detected in the parks during the current year.
- Graph the abundance of each marine organism or group detected during the current year in each park as part of a continuous multi-year plot.
- Indicate the species richness at each site within a park.
- Identify any data quality concerns and/or deviations from protocols that affect data quality and interpretability.

Recommend analyses appropriate for annual reporting including example figures are provided in **SOP 9: Data Analysis**.

A more in-depth analysis and report will be produced every 5 years. In addition to the above, the 5-year report also will:

- Provide annual density estimates for each species/group during the previous five years.
- Provide a summary and detailed trend results for major species/functional groups with an adequate sample size for estimating density and assessing trend.
- Assess spatial patterns in the intertidal community composition (at sites and parks).
- Identify any possible changes within the parks.
- Place network extensive rocky shoreline monitoring results within the larger context of coastwide regional trends in the MARINe/PISCO west coast monitoring network.
- Evaluate operational aspects of the monitoring program.

Standard Report Format

Annual reports and trend analysis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. Annual reports will use the Natural Resource Technical Report (NRTR) template, and trend analysis and other peer-reviewed technical reports will use the Natural Resource Report (NRR) template. These templates and documentation of the NPS publication standards (National Park Service 2005) are available at: http://www.nature.nps.gov/publications/NRPM/index.cfm.

Review Products for Sensitive Information

Before preparing data in any format for sharing outside NPS – including presentations, reports, and publications – the Project Lead should refer to the guidance in the next section. Certain information that may convey specific locations of sensitive resources may need to be screened or redacted from public versions of products prior to release.

J. Identifying and Handling Sensitive Information

Certain project information related to the specific locations of rare or threatened taxa may meet criteria for protection and as such should not be shared outside NPS except where a written confidentiality agreement is in place prior to sharing. Before preparing data in any format for sharing outside NPS – including presentations, reports, and publications – the Project Lead should consider whether or not the resulting information might put protected resources at risk. Information that may convey specific locations of sensitive resources may need to be screened or redacted from public versions of products prior to release.

Although it is the general NPS policy to share information widely, the NPS also realizes that providing information about the location of park resources may sometimes place those resources at risk of harm, theft, or destruction. This can occur, for example, with regard to caves, archeological sites, tribal information, and rare plant and animal species. Therefore, information will be withheld when the NPS foresees that disclosure would be harmful to an interest protected by an exemption under the Freedom of Information Act (FOIA). The National Parks Omnibus Management Act, Section 207, 16 U.S.C. 5937, is interpreted to prohibit the release of information regarding the "nature or specific location" of certain cultural and natural resources in the national park system. Additional details and information about the legal basis for this policy are in the NPS Management Policies (National Park Service 2006), and in Director's Order 66 (available at: http://home.nps.gov/applications/npspolicy/DOrders.cfm).

These guidelines apply to all NCCN staff, cooperators, contractors, and other partners who are likely to acquire or otherwise have access to information about protected NPS resources. The Project Lead has primary responsibility for ensuring adequate protection of sensitive information related to this project.

The following are highlights of our strategy for protecting this information:

- *Protected resources,* in the context of the NCCN Inventory and Monitoring Program, include species that have State- or Federally-listed status, and other species deemed rare or sensitive by local park taxa experts.
- *Sensitive information* is defined as information about protected resources that may reveal the "nature or specific location" of protected resources. Such information must not be

shared outside the National Park Service, unless a signed confidentiality agreement is in place.

- In general, if information is withheld from one requesting party, it must be withheld from anyone else who requests it, and if information is provided to one requesting party without a confidentiality agreement, it must be provided to anyone else who requests it.
- To share information as broadly as legally possible, and to provide a consistent, tractable approach for handling sensitive information, the following shall apply if a project is likely to collect and store sensitive information:
    - Random coordinate offsets of up to 2 km for data collection locations, and
    - Removal of data fields likely to contain sensitive information from released data set copies.

We do not anticipate that this monitoring project will collect, manage or report on information related to protected resources. As a result, there are no plans to implement coordinate offsets or data redaction. However, project data will be evaluated on an annual basis in case information on protected resources is included. If so, data will be handled in keeping with network standards (Boetsch et al. 2009), and an SOP will be developed with handling procedures specific to this protocol.

K. Product Delivery, Posting and Distribution

Refer to **SOP 10: Product Delivery, Posting and Distribution** for the complete schedule for project deliverables and instructions for packaging and delivering them. Upon delivery products will be posted to NPS websites and clearinghouses (e.g., IRMA, NPSpecies, NPS Data Store) as appropriate.

Holding Period for Project Data

To permit sufficient time for priority in publication, certified project data will be held upon delivery for a period not to exceed 2 years after data certification. After the 2 year period has elapsed, all certified, non-sensitive data will be posted to the NPS Data Store. Note: This hold only applies to raw data, and not to metadata, reports or other products which are posted to NPS clearinghouses immediately after being received and processed.

Special Procedures for Sensitive Information

Products that have been identified upon delivery by the Project Lead as containing sensitive information will normally be revised into a form that does not disclose the locations of protected resources – most often by removing specific coordinates and only providing coordinates that include a random offset to indicate the general locality of the occurrence. If this kind of measure is not a sufficient safeguard given the nature of the product or the protected resource in question, the product(s) will be withheld from posting and distribution.

If requests for distribution of products containing sensitive information are initiated by the NPS, by another federal agency, or by another partner organization (e.g., a research scientist at a university), the unedited product (i.e., the full data set that includes sensitive information) may be shared only after a confidentiality agreement has been established between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. Refer to **Section 4J, Identifying and Handling Sensitive Information** for more information.

Integration with MARINe Database

Certified data will be exported from the project database on an annual basis for integration with the MARINe database (http://www.sccwrp.org/view.php?id=380), which is an online application supported by the Southern California Coastal Water Research Project (SCCWRP). SCCWRP has created Standardized Data Transfer Formats (SDTFs) that allow diverse users to submit data in a standardized fashion. Our database export will meet this transfer format to allow integration and online browsing of data through the SCCWRP website.

L. Archiving and Records Management

All project files should be reviewed and organized by the Project Lead on a regular basis (e.g., annually in January). Unneeded draft documents and other intermediate files should be deleted to conserve space and maintain a clear and unambiguous record for future project staff. See **SOP 6: Project Workspace and Records Management** for more details. Decisions on what to retain and what to destroy should be made following guidelines stipulated in NPS Director's Order 19 (available at: http://home.nps.gov/applications/npspolicy/DOrders.cfm), which provides a schedule indicating the amount of time that the various kinds of records should be retained.

Because this is a long-term monitoring project, good records management practices are critical for ensuring the continuity of project information. Files will be more useful to others if they are well organized, well named, and stored in a common format. Details for handling project files are described in **SOP 6: Project Workspace and Records Management**. In addition, files containing sensitive information must be stored in a manner that will enable quick identification. Refer to **Section 4J, Identifying and Handling Sensitive Information**.

M. Season Close-out

After the conclusion of the field season, the Project Lead, Data Manager, and GIS Specialist should meet to discuss the recent field season, and to document any needed changes to the field sampling protocols, to the database structure or front-end application, or to any of the SOPs associated with the protocol.

5. Personnel Requirements and Training

A. Roles and Responsibilities

The roles associated with this protocol are Project Lead, Field Lead, Technicians, Data Manager, Data Analyst, GIS Specialist, and Park Curator. Specific responsibilities associated with the roles are found in Table 4, and the information management task list associated with these roles and responsibilities are found in **Appendix 1. Yearly Project Task List.**

Table 4. Roles and responsibilities for Intertidal Monitoring in the NCCN.

Role	Responsibilities	Name / Position
Project Lead	• Project oversight and administration • Track project budget, information requirements, and progress toward meeting project objectives • Facilitate communications between NPS and cooperators • Primary point of contact for data requests • Coordinate and ratify changes to protocol • Provide training to Field Lead, assist in conducting field work • Maintain and archive project records • Review and certify each season's data for quality and completeness • Complete and deliver reports, certified data, metadata, and other products as scheduled and according to Inventory and Monitoring Program specifications	Steven Fradkin, Coastal Ecologist, OLYM
Data Analyst	• Perform data summaries and analysis, interpretation and report preparation	
Field Lead	• Train and ensure safety of field crew • Plan and execute field visits • Acquire and maintain field equipment • Oversee data collection and data entry • Conduct database audits to verify complete and accurate data transcription • Review and archive field forms • Complete a field season report	Biological Science Tech (GS-6)
Technicians	• Conduct field work to collect field data, data photos, and sediment samples • Enter field data into the project database, and verify database records for accuracy • Download and import temperature data from data loggers to the project database • Download and process photographic images • Score rocky shoreline photoplot images and enter scoring data into the project database • Process sediment samples for composition	Biological Science Technicians (GS-5) and Student Conservation Association interns
Data Manager	• Consult on data management activities • Facilitate check-in, review and posting of data, metadata, reports, and other products to national databases and clearinghouses according to schedule • Maintain and update database application • Provide database training as needed	John Boetsch, Data Manager, NCCN*

Table 4. Roles and responsibilities for Intertidal Monitoring in the NCCN (continued).

Role	Responsibilities	Name / Position
GIS Specialist	• Consult on spatial data collection, GPS use, and spatial analysis techniques • Facilitate spatial data development, GPS data processing, and map output generation • Work with Project Lead and Data Analyst to analyze spatial data and develop metadata for spatial data products • Primary steward of GIS data and products	Katherine Beirne, GIS Specialist, NCCN*
Network Program Manager	• Review annual reports for completeness and compliance with I&M standards and expectations	Mark Huff, NCCN Network Program Manager
Park Curator	• Receive and catalogue voucher specimens • Receive and archive copies of annual reports, analysis reports, and other publications • Facilitate archiving for other project records (e.g., original field forms, etc.)	Park Curators at OLYM

* These individuals act as coordinators and primary points of contact for this project. Their responsibility is to facilitate communication among network and park staff and to coordinate the work which may be shared among various staff to balance work load and to enhance the efficiency of operations.

B. Qualifications

In order to collect standardized long-term data, a certain level of taxonomic expertise is required for field staff. Because the intertidal zone of the NCCN is host to a wide diversity of marine taxa that require uncommonly found taxonomic expertise, two strategies have been employed to minimize the extent of taxonomic expertise required. First, only upper-elevation communities are being monitored. Taxonomic diversity generally increases in the lower tidal zone, and this area is not being targeted by this protocol. Second, certain taxa will be grouped into higher taxonomic levels and/or functional groups (i.e. articulated corallines, red-blade algae, chitons). Analyses of MARINe photoplots will be conducted by either the Field Lead or Project lead, who are highly trained intertidal ecologists. Field technicians will be required to be physically fit in order to endure long days of fieldwork that require hauling heavy backpacks (up to 50 lbs) through wilderness areas.

C. Training Procedures

Technicians and any new Field Leads must go through a training period (late March through April) with the Project Lead. New Field Leads must undergo an entire season of monitoring prior to leading the analysis of Community Rocky Platform photoplots or MARINe plots. Standard training for all field crew members will include the following:

- A program overview with discussion of goals, objectives and standard operating procedures.
- Safety training that covers safe field practices and safe use of project equipment.
- Required readings. Technicians will be given a copy of the protocol and other reference materials for review.
- Hands-on laboratory instruction. Prior to conducting field work, technicians will learn to identify all project target taxa using a combination of pictures, guides, and preserved voucher specimens.

- Hands-on field instruction. Technicians will be shown how to conduct all SOPs, including identification of target taxa, in the field.
- Forms. Technicians will be shown the proper way to fill out all field and laboratory forms.
- Data Entry. Technicians will be shown the proper method for entering data into the database, in addition to demonstration of all data QA/QC procedures.

Technicians will work directly with the Field Lead until the Field Lead is satisfied that technicians are capable of operating independently.

D. Safety

Personal safety is the number one priority at all times in the field and laboratory. At no time are staff expected to participate in operations that appear dangerous or risky. The intertidal zone is an inherently dangerous place as the interface between the land and the ocean. Travel and work in the intertidal, particularly on rocky shores which are encrusted with slippery organisms, requires careful, methodical movement. Awareness of weather, swell, and waves is crucial to safe coastal conduct. All field personnel are required to participate in an annual field safety program that covers standard safe field practices in the intertidal zone.

6. Operational Requirements

A. Annual Workload and Field Schedule

A detailed schedule for project activities is found in **Appendix 1: Yearly Project Task List**. In brief, hiring of field crews is conducted from February through March. The field crew members conduct data collection, entry and download from late-May until mid-August. Crew members will typically be retained through September to work as part of the NCCN Mountain Lakes Monitoring Protocol crew. In preparation for the field season, new or replacement equipment orders will be placed in March and April each year, and the computer workspace and database set-up will be completed by April 15. Field crew training will occur during May, with field work conducted for the rest of the field season. Following the field season, the Project Lead and other NPS staff members will evaluate the protocol and assess whether changes are needed. The Project Lead is responsible for data certification by the end of November. Data will be analyzed and a report generated by the project lead during February to April, to be delivered to the NCCN Program Manager by May 1. The project will require some support from GIS staff for GPS training, downloading of GPS units during the field season, and generating occasional map output.

B. Facility and Equipment Needs

This protocol requires a rudimentary lab facility and certain essential field and lab equipment. Necessary field and lab equipment are listed in each SOP. The Lake Crescent Laboratory at OLYM will serve as the central lab facility for this project. The lab has computers with NPS network access for data management, a wet-lab, microscopy room, and marine library for the identification and processing of collected specimens. Field crews are typically housed in park housing within a short commuting distance from the lab on Lake Crescent. NPS vehicles are required for transport of field crews to coastal trailheads.

C. Startup Costs and Budget Considerations

This project has relatively low start-up costs because most equipment needs have already been paid for in the pilot stage of protocol development. The annual budget for the NCCN Intertidal Monitoring Project (Table 5) includes Field Lead and Technician personnel costs, along with a modest equipment budget and travel related costs within OLYM and to LEWI and SAJH. Other staffing costs are covered as in-kind services paid for either by OLYM base funds (i.e. Project Lead) or by NCCN I&M base funds (i.e. Data Manager, GIS Specialist). Rocky Intertidal monitoring at Ecola State Park in LEWI is currently conducted by MARINe staff, assisted annually by the Project Lead. When and if MARINe staff cease to monitor this site, NCCN staff will take over these monitoring activities. Temperature and Sand Beach monitoring at LEWI are conducted by NCCN staff.

Table 5. Intertidal monitoring protocol projected budget.

Project Stage / Budget Category	Personnel	Grade	Pay Periods	NCCN Intertidal Protocol Cost	In-Kind Support (OLYM or NCCN Base)	Data Management Costs
Preparation	Project Lead	GS-12	1		$3,805	
	Physical Science Tech	GS-7	0.5	$1,282		
	Field Lead	GS-6	0.5	$707		
	Technician	GS-5	0.5	$634		
	Data Manager	GS-11	0.5		$1,540	
Data Acquisition, Entry & Processing	Project Lead	GS-12	3		$11,415	$3,425
	Physical Science Tech	GS-7	1.5	$3,848		$770
	Field Lead	GS-6	6.8	$9,616		$1,923
	Technician	GS-5	5.5	$6,974		$1,395
	Student Intern	SCA	16 weeks	$5,000		$1,000
Quality Review	Project Lead	GS-12	0.3		$1,141.50	$1,141
	Data Manager	GS-11	0.5		$1,540.00	$1,540
	GIS Specialist	GS-9	0.3		$875.40	$875
Metadata	Project Lead	GS-12	0.15		$571	$571
	Data Manager	GS-11	0.1		$308	$308
Data Certification & Delivery	Project Lead	GS-12	0.1		$380	$380
	Data Manager	GS-11	0.6		$1,848	$1,848
Data Analysis	Project Lead	GS-12	1.5		$5,708	$5,708
Reporting & Product Development	Project Lead	GS-12	1.5		$5,708	$5,708
	Field Lead	GS-6	0.2	$283		$283
	Data Manager	GS-11	0.05		$154	$154
	GIS Specialist	GS-9	0.1		$292	$292
Product Delivery, Posting & Distribution	Data Manager	GS-11	0.3		$924	$924
	NCCN Program Manager	GS-12	0.05		$190	$190
Archival & Records Mgmt.	Data Manager	GS-11	0.1		$308	$308
	Project Lead	GS-12	0.2		$761	$761
Season Close-out	Field Lead	GS-6	0.5	$707		
	Project Lead	GS-12	0.2		$761	
	Data Manager	GS-11	0.3		$924	$924
Travel				$1,380		
Vehicles						
Supplies				$1,600		
Total				$32,031	$39,154	$30,428

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Standard Operating Procedures

Rocky intertidal habitat in Gilbert Cove, Point of Arches, OLYM.

SOP 1: MARINe Target Species Rocky Monitoring

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Jan 2009	S.C. Fradkin	---	Original
Jan 2010	S.C. Fradkin	Minor clarifications	Peer-review revisions
Jan 2012	S.C. Fradkin	Site Photos Added	Clarification and completeness

Introduction

MARINe Target Species plots follow the established methodology of the Multi-Agency Rocky Intertidal Network (MARINe) to allow comparison with similar plot types at NPS and other locations along the West Coast of North America (Engle 2005, Miner et al. 2005, Ammann and Raimondi 2008). This SOP uses fixed plots (e.g. Figure S1.1) that target each of two core species assemblages, barnacles and mussels, with 5 replicate plots of each assemblage at each site.

Figure S1.1. Barnacle MARINe fixed plots at Point of the Arches, OLYM.

Field Equipment Needed

- Clipboard
- Maps, directions, site photos
- Sampling protocol
- Camera
- Collapsible camera framer (for 50 x 75 cm photo plots)
- Data sheets (Attachments S1.1, S1.2)
- Field Log
- Rock Hammer Drill (for site set-up)
- Z-spar marine epoxy (for plot marking and maintenance)
- ¼" x 3" Stainless Steel Bolts (for marking corners of photo plots)
- Stiff paint scraper
- Wire brush

Field Scoring Equipment:

- PVC Scoring quadrat
- Tally counter(s)
- Plot scoring datasheet
- Kneepads

Laboratory Scoring Equipment:

- Digital plot photos
- Computer workstation
- Graphics software (Photoshop Elements, Photoshop GS, etc.)
- Field Notes
- MARINe Site Plot Scoring Data Sheets (Attachment S1.2)
- Multi-bank Tally Counter
- Pencil

Standard Operating Procedure

Monitoring Schedule

MARINe Target Species sampling will be conducted in the summer months during morning low tides of sufficient elevation to allow adequate working time, generally on tides of 0.0 ft or less.

Establishment of New Plots and Plot Maintenance

Permanent photo plots were established during initial site set-up. Each plot is relatively flat, without pools, and initially contained approximately >70% cover of the target species (barnacles or mussels). Acceptable plot photos use a narrow field of focus with few shadows from surface relief (cracks, boulders, etc.) or reflections from pools. Steps for establishing new plots include:

1. Locate plot position.
2. Clear a 5 x 5 cm area to bare rock below each quadrat corner using a stiff paint scraper and wire brush as needed.
3. Use a hammer drill to make a 2” deep, 5/8” diameter hole in the substrate in the top left and bottom right corner of the plot. Insert a wad of Z-spar epoxy into each hole and then insert a stainless steel marker bolt. Place a dollop of Z-spar in the top right and bottom plot corners to mark them. Write the plot number in spare Z-spar epoxy around the base of the marker bolt in the top left corner of the plot. Use the convention **X-Y**, where X = “B” for barnacle or “M” for mussel, and Y= 1-5 for plot number.
4. Take GPS coordinates for general plot locations, and take ample site photographs with photo framer in place with key landmarks in view to facilitate finding site during subsequent visits. Measurements (bolt-to-bolt distances and compass bearings) between plots are recorded on the Interplot Measurement Datasheet (Attachment 1A) to aid in plot location in the event of bolt overgrowth by encrusting organisms.
5. During revisits in subsequent years, plot corners can become overgrown, especially in the mussel zone. Make sure to clear all corners on each visit.
6. In mussel plots that may become too overgrown, longer stainless steel bolts (4-6”) are used to mark the two corners.

Plot Photography

1. Assemble photo-frame (see Figure S1.2) and mount camera.
2. Locate plots using area photos, plot photos, site maps, etc.
3. Locate plot boundaries by identifying all plot corners. Do not step on or otherwise disturb organisms within the photo plot. Photos should show algae or invertebrates in their original position.
4. Verify proper plot orientation using reference photos and corner markers.
5. Place the photo-frame over the plot, lining up the frame corners with the corner markers, making sure that the numbered plot bolt is in the upper left corner and that the photo-frame flat is on the plot.
6. Write the site code and date on the erasable tablet attached to the photo-frame and make sure the tablet is within the photo area. This label will appear in the photo as an embedded record of the plot type and number in case the photo file is mislabeled later (see Figure S1.3).
7. Check the camera settings and that all the frame corners are within the photo area on the camera’s LCD screen.
8. Hold the photo-frame steady and take a picture of the plot. Check the picture on the camera’s LCD screen to make sure that the plot is fully within the photo and that the picture is in focus.
9. Repeat step 8 to take a second photo of the plot.
10. Record the sequence of photos and any relevant issues or problems on the **Intertidal Field Log Data Sheet (Attachment S1.1)** for use in later photo labeling and metadata procedures.

11. Before moving on to the next plot, make sure that all the plot corners are clear of growth and that Z-spar epoxy markers are sound. Repair corners if needed and note any repairs/observation on the field log data sheet.
12. Repeat steps 2-11 above for each plot at the site. **Make sure to re-label the erasable tablet on the Photo-frame after each plot**.
13. Disassemble quadrapod and store camera until ready to proceed with shooting area photos

Figure S1.2. An example photo-frame for photographing permanent 50 x 75 cm barnacle and mussel plots. Actual frame designs vary and may be constructed of ½”, ¼” PVC or ¼” wood dowel materials. Essential features include the 50 x 75 cm interior dimensions of the bottom frame, an approximate 1m distance from bottom frame to camera (top) frame, and an attachment mechanism for the camera to the top frame, and a zip-tied slate (plastic electric plug cover) attached to the bottom frame that is visible in the camera field of view. Using a grease-pencil, this slate provides a label for each photo taken.

Figure S1.3. An example mussel Target Species photoplot from the Point of the Arches site (OLYM). Note that substantial barnacle overgrowth occurs over the mussel bed.

<u>Site Area Photos</u>

Panoramic photos of the overall site provide a habitat-level record that places plots into the context of the surrounding area and can aid interpretation of patterns observed in the plots (Figure S1.1). Where necessary, individual photos can be stitched together using a variety of software packages (e.g. ArcSoft Panorama Maker 3.0). Additional individual digital photos are taken of unusual or interesting phenomena in the site, such as substrate degradation, poor organismal health (i.e. bleached algae, barnacle scars, etc.), intrusion of sand, noticeable recruitment events, interesting species aggregations, presence of oil or pollutants, and effects of human trampling. Steps for taking site overview photos include:

1. Identify a reference location based upon landmarks… verify this location through the use of an initial site photograph that identifies the vantage point for the site panoramic photos. Place a small dollop of Z-spar to further mark the site. A Z-spar/landmark based location is preferable to placing a bolt in the substrate in order to reduce the number of bolts being placed in the park environment. Use the automatic setting on the digital camera. Avoid placing the sky or sea as the main focal point as it will alter the exposure quality and reduce the utility of the photograph.
2. For panoramic photos include sequential, overlapping habitat photos (i.e. “pans”) taken while rotating the view area from left to right from the fixed epoxy reference point. Keep the camera level and overlap approximately 1/3 of the image in each frame.

3. Record notes on the **Intertidal Field Log Data Sheet** (Attachment S1.1). Indicate number of photos in each panoramic series.

Plot Scoring

Data are extracted from fixed-plots in one of two ways. The preferred way will be to score plots in the field, with a photo backup. The alternate method will rely solely on the plot photo scored away from the field in the laboratory. This alternative will only be chosen if field conditions (e.g. incoming tide) preclude field scoring. Both scoring options will use the fixed-point contact method with 100 systematically placed points. A percent cover estimate for a set of target organisms is obtained by identifying organisms under each of the 100 point intercepts.

Fixed-Plot Scoring Rules

1. Review all relevant field notes, site photos, plot sketches, etc. that may assist in interpreting the data photo. Field notes etc. may provide information on dominant species, potentially obscure and or undifferentiated species.
2. The 100 point contacts treat the plot as potentially consisting of two layers, but normally consisting of only one layer. A point contact will consist of two layers if the plot target species (barnacle or mussel) under the point is covered by one of the following taxa: *Fucus, Endocladia, Balanus, Chthamalus.* In this case Layer 1 will be the cover taxon and Layer 2 will be the target species. When two individuals of the same taxa cover each other, they will be treated as one layer. When a single taxon is present under the point contact, that taxon will be recorded as Layer 1.
3. As part of the export action to the MARINe database from the NCCN database, Layer 1 and Layer 2 will be condensed into a single layer to be consistent with MARINe database requirements. This condensation will merge Layer 2 as the dominant layer such that the single layer approach as outlined in the Marine Handbook (Engle 2005) is preserved. The NCCN will track two layers because layering by non-weedy epibionts is common in the NCCN (for example, see the barnacle cover of mussel beds in Figure S1.3) Trends in the persistence of non-weedy epibionts is of interest to the NCCN.
4. For each plot, only 100 scored identifications will be made. Layers 1 and 2 will never have more than a total of 100% cover for all species and bare space combined each.
5. Point contacts are true points, they can only “contact” one organism, although a second organism can underlay a point (see above).
6. Organisms are identified to the taxonomic level illustrated on the **NCCN Intertidal MARINe Plot Scoring Data Sheet** (Attachment S1.2).
7. When target species are clearly covered by a weedy alga (*Ulva/Enteromorpha* and *Porphyra*), these algae are not scored. These algae are only scored if they occur on bare substrate or if the dominant organism under them is not obvious.
8. Weakly mobile invertebrates (i.e. limpets, snails) are not scored.
9. Score only sedentary mobile invertebrates *Pisaster ochraceus* (PIOC) and chitons (CHITO) under point contacts.
10. Score bleached (white) “crustose corallines” as CRUCO not rock (R), as these algae may still be alive.

11. Score obviously dead organisms (i.e. barnacle tests, basal plates, etc.) as DEAD. These will be analyzed as bare space (Rock), but are useful in establishing mortality.
12. When sand is present under a point, if an identification of the rock substrate of covered organism is possible, do so, otherwise score the point as sand. “Sand” will only be scored if the sand thickness is greater than a thin layer (i.e. 1 mm).
13. Thin (non-obvious) layers/films of algae are scored as Rock, while thick, multiple celled algal layers should be scored as non-coralline crusts (CRUST).
14. Unknown species will be scored as either “other algae” (OB, OG, OR) or “other invertebrate” (OI).
15. Plants attached to substrate outside of the plot (except the “weedy species” above), but draping into the plot will be scored without regard to place of attachment.

Field Scoring Procedures

The field scoring frame is a rectangle made of ¾ “ PVC pipe with glued joints finished to an inside dimension of 50 cm x 75 cm. Ten lines (fishing line) are permanently affixed (knotted) and stretched at regular intervals between the short-side (50 cm) dimension and ten lines are permanently affixed and stretched at regular intervals between the long side (75 cm) dimension, creating a matrix with 100 points at the intersection of perpendicular lines.

1. Field scoring is easiest with two people, a scorer and a data recorder.
2. Place the 50 x 75 cm frame on the plot in the proper orientation
3. Identify species occurring directly below the point-intercept along the gridlines.
4. Follow the scoring rules without exception.
5. At each point-intercept read off the taxa by layer to the data recorder who will create a tally on the **NCCN Intertidal MARINe Plot Scoring Data Sheet** (Attachment S1.2). The data recorder needs to carefully check the scoring to ensure that the correct numbers of tallies are made for each taxon. Clear communication between the scorer and data recorder is essential.
6. Work through each point contact methodically in the same procession to ensure correct coverage.
7. After each plot is completed, count up the tally and write the number for each taxon and circle it. Check to make sure that the total number for Layer 1 equals 100. Erase extraneous marks and make sure that numbers are legible.

Laboratory Scoring Procedures

Plots photos scored in the laboratory will use the fixed-point contact method with the aid of a computer graphics package such as Photoshop, etc. The software package is used to overlay a grid of 100 systematically spaced points onto the digital plot image. Laboratory scoring of photos will be conducted only by the project lead or specially trained technicians familiar with the appropriate taxonomic identification.

Procedure for Laboratory Photoplot Scoring of Digital Plot Photos Using Photoshop Software

1. Open Photoshop.

2. Under “File”, open ‘2x3 grid w/ 100 pts’ (The 100pt overlay file template).
3. Overlay the 100pt grid using cursor in select mode + to highlight (include the yellow outline that contains the 100 pts).
4. Copy grid (Edit → Copy).
5. Open data digital photo to be scored.
6. Paste grid onto photo.
7. To fit grid to the photo, go to Edit → free transform.
8. Move grid so that all points are within plot but that grid is at its maximum coverage.
9. Hit Enter to apply the grid, then you can apply/remove it by clicking on/off the layer window (grid is layer at this point).
10. Score the photo using “Scoring Rules”. Zoom in and out of the quadrats using the navigator window. Generally score at full view of one quadrant, with the ability to zoom in to points as necessary.
11. If points are too dark to score, adjust the brightness/contrast by selecting the point and go to Image →Adjust → Levels and move the middle arrow to adjust the level.
12. Using a multibank tally counter, with appropriate species designated to each tally, count species occurring directly below the 100 pts.
13. Work *methodically* (i.e. left to right, up to down) in the same way each plot. This will help to retain memory and place as you read the 100 pts.
14. Transcribe data from bank tally to datasheet as you complete each plot. Be sure not to reset tally BEFORE data are transcribed to datasheet, otherwise you will have to rescore the 100 points!
15. Double check that datasheet column is correctly labeled with the appropriate plot number, and that the column adds up to 100. Make sure all numbers are legible.
16. Once finished scoring, go to Layer → Merge visible (there should now only be one layer in the layer window).
17. Select File →Save As → jpeg to save the scored image as the original filename with a “g” (for “*grid*”) added at the end of the file name to differentiate the scored grid slide from the original.
18. Move to the next photoplot record, and repeat procedure.

Additional Scoring Quality Control

1. After scoring, make sure that datasheet is legible, all headers are filled in, and that plot column totals equal 100.
2. Look over data sheet for any obvious errors, then initial and date the QA/QC section on the bottom of the datasheet.

Deviations from MARINe Handbook Procedures

1. Layering is handled differently in the NCCN procedures. Rather than score only a single dominant layer (MARINe standard), the NCCN scores up to two layers to capture the occurrence of “non-weedy” epibionts that can be important community constituents. Further rationale for this deviation is given above in “Fixed-Plot Scoring Rule #3”.
2. Two plot marker bolts with 2 epoxy markers are used instead of the MARINe standard of 3 bolts. Extensive experience on the OLYM coast has shown that bolts are recoverable if

surveyed and maintained on an annual basis. Wilderness "minimum tool" restrictions require the minimal use of permanent markers in the intertidal.

Taxonomic Keys Used for Identification and Training

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Site Directions and Locations

OLYM

Site access at OLYM requires both drive time and hiking time. Depending upon the timing of tides, driving and/or hiking to sites with overnight camping may be required. Plot locations within sites are illustrated in Figures S1.4 – S1.10.

Point of the Arches

The drive: (same as Point of Arches temperature datalogger) ~ 2 hours from Lake Crescent Lab. Drive to Neah Bay through town on Hwy 112. Follow signs to Fish Hatchery, stay to the right. If staying overnight, park at the house ($10) at the top of the hill.

The hike: 3 miles from Makah trailhead parking lot, along muddy coastal trail to Shi Shi beach. Then hike 3 miles to the south end of Shi Shi beach.

Sokol Point
The drive: Take US-101 to state highway west 110. Park at the Rialto Beach parking lot near the Mora ranger station.(~1 ½ hours from lab). Take Hwy 112 west, follow signs for Lake Ozette.
The hike: Hike 4.5 miles north along Rialto beach to Sokol Point.

Taylor Point
The drive: about 1 hour from lab to Third Beach. Take Hwy 101 west. Turn right on La Push Rd, trailhead on the left.
The hike: from Third Beach trailhead, about 3 miles past Third Beach and overland trail around Taylor Point. The non-beach trail can be very muddy w/ rope ladders. Beach hiking is on fine sandy beach.

Starfish Point
The drive: about 2 hours on Hwy 101 to the Beach 4 parking lot.
The hike: down short trail to beach, turn north and hike along sand beach to first rocky headland.

LEWI
The drive: The Ecola State Park unit is readily accessible off US-101 through the town of Cannon Beach, OR.
The hike: Access to the site is from the Ecola State park parking lot. Contact the local ranger prior to parking to avoid being ticketed in the parking lot.

SAJH
English Camp
The drive: Take the Roche Harbor road on San Juan Island north to English Camp.
The hike: From the English Camp parking lot, hike 0.4 miles on the Bell Point trail to Bell Point.

American Camp
The drive: Take Cattle Point road south, once inside the park boundary, turn right on Pickett Lane and park at South Beach parking lot.
The hike: From the South Beach parking lot, hike west ~1 mile to the headland just east of Grandma's Cove.

UTM coordinates for NCCN site locations appear below in Table S1.1. Plot locations within sites are located using a combination of site photos and interplot measurements.

Table S1.1. UTM coordinates for NCCN MARINe Target Species monitoring sites.

Park	Site Name	UTM E	UTM N
OLYM	Point of Arches	373344.6	5344529.3
	Sokol Point	375918.5	5311733.3
	Taylor Point	382722.5	5302594.9
	Starfish Point	375499.0	5278638.1
SAJH	American Camp	498297.9	5367159.8
	English Camp	488477.0	5382300.5
LEWI	Ecola	423938.7	5086797.2

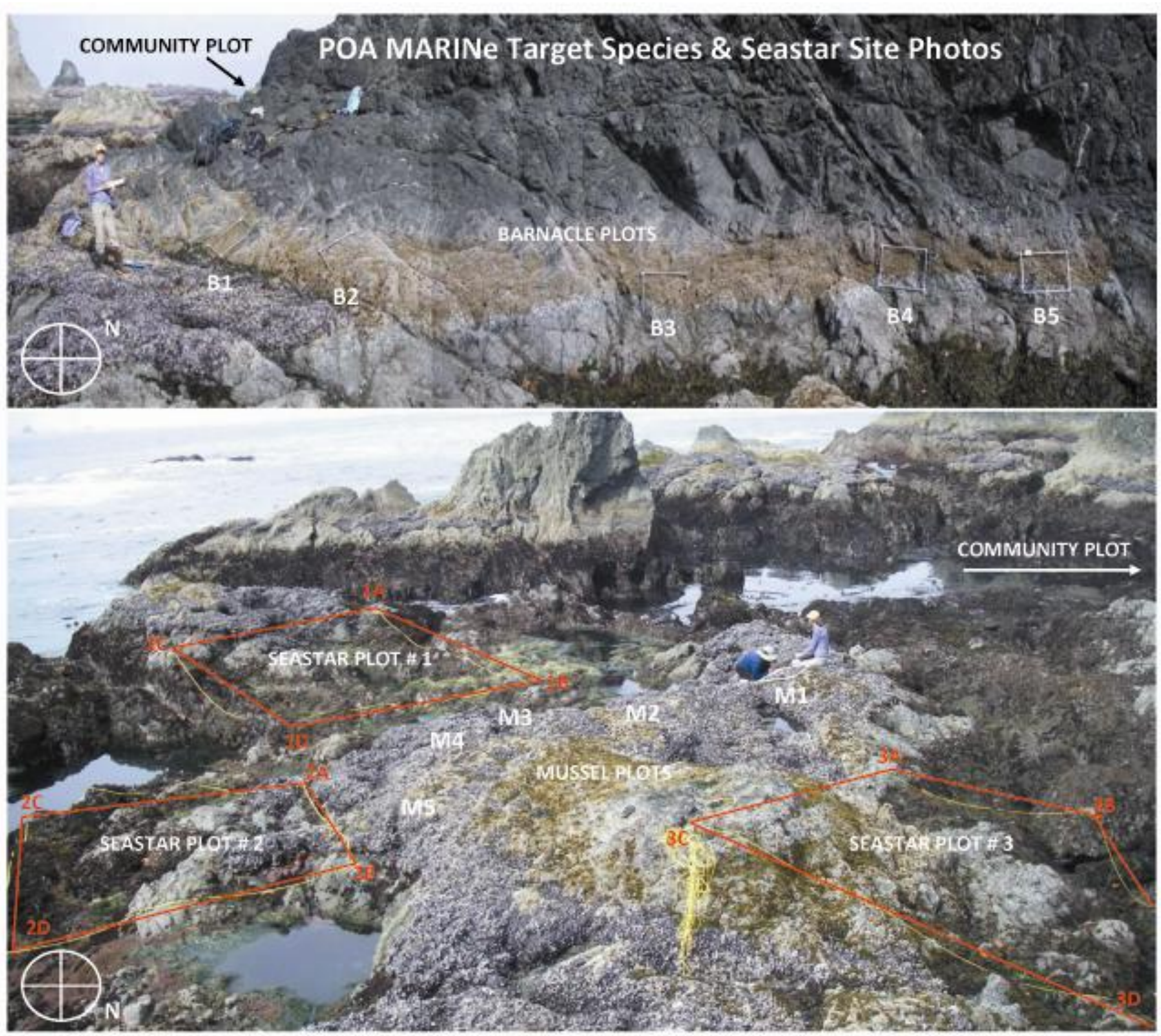

Figure S1.4. Location of MARINe Target Species and Seastar plots at the Point of Arches (POA), OLYM.

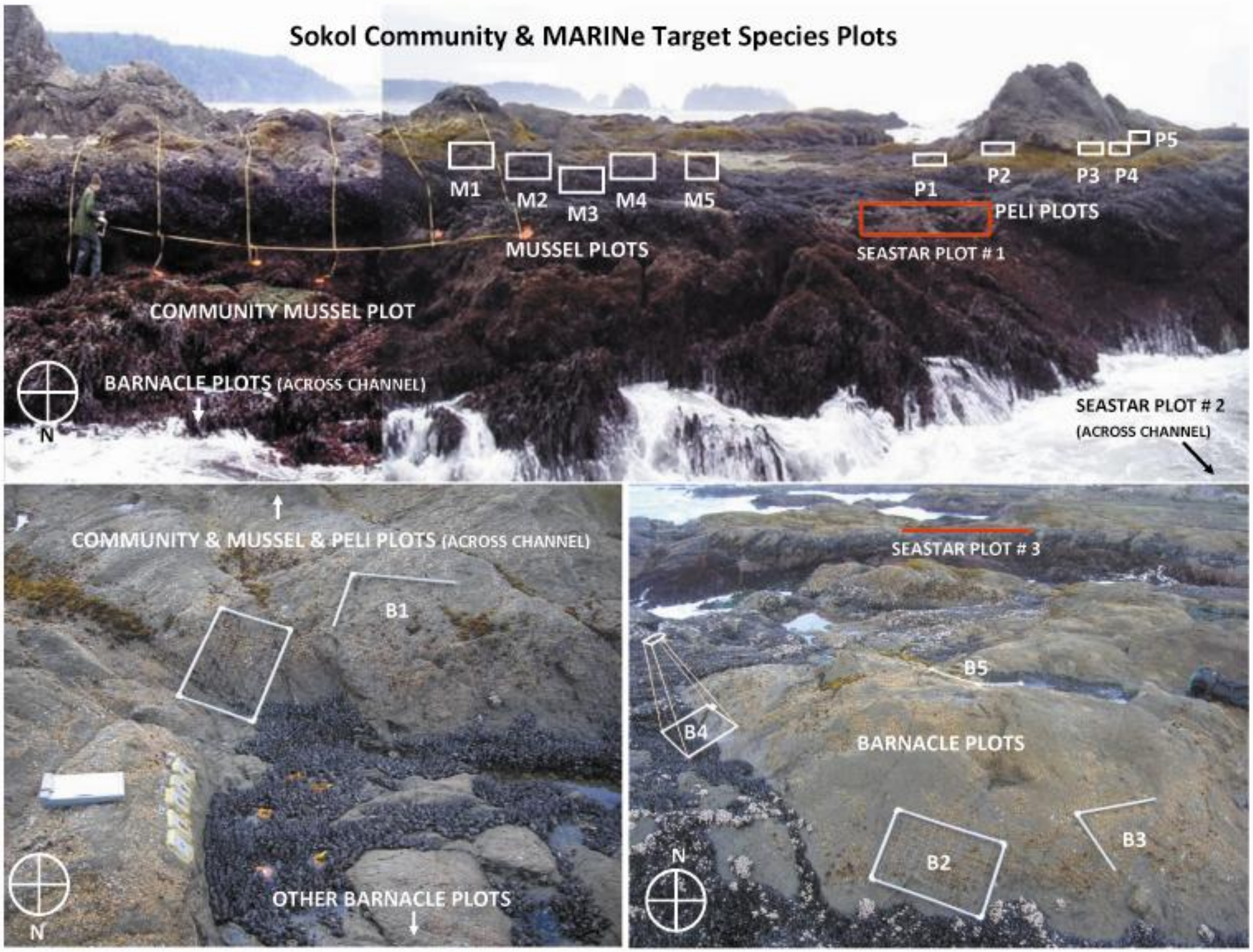

Figure S1.5. Location of MARINe Target Species and Seastar plots at Sokol Point, OLYM.

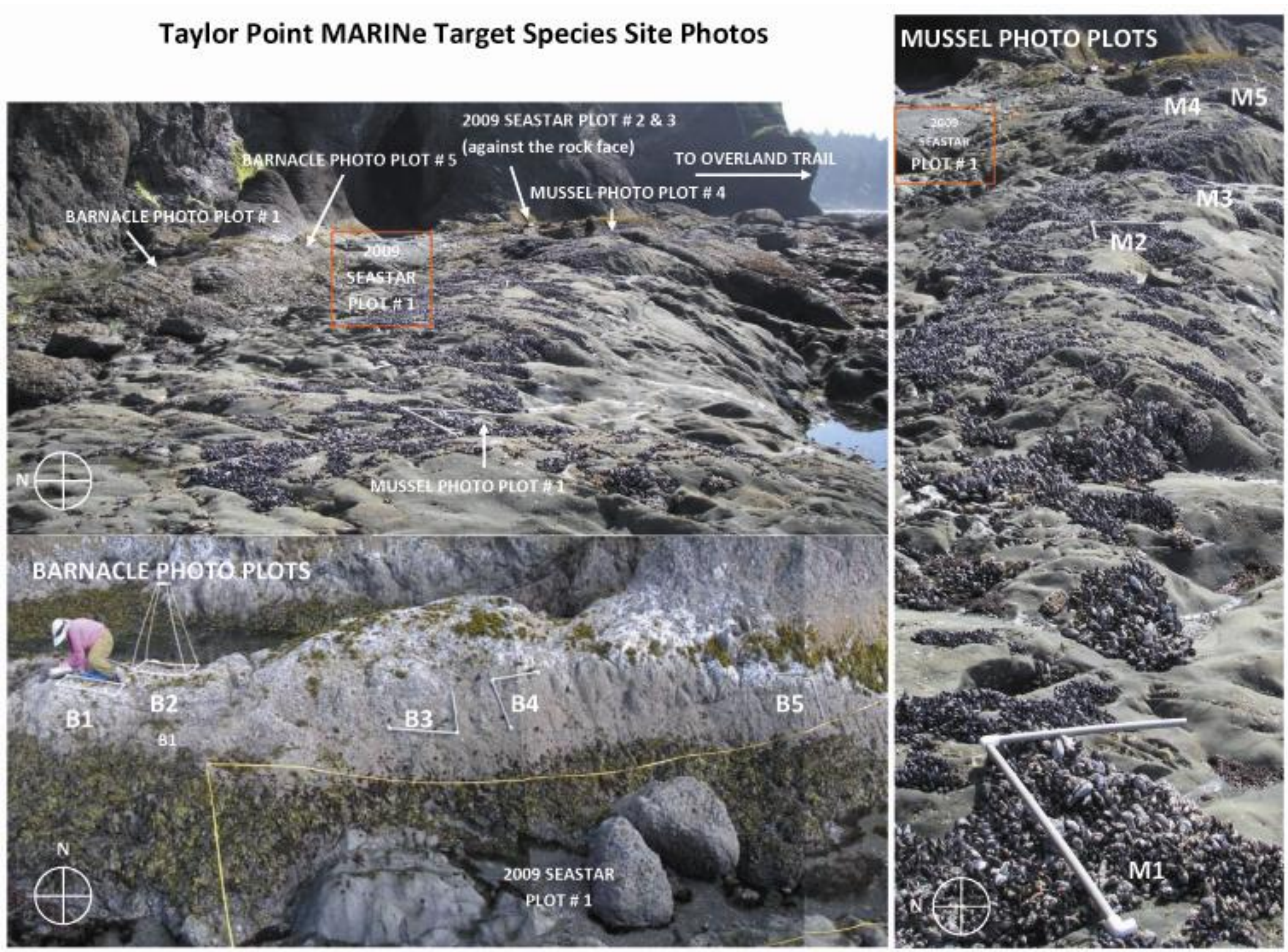

Figure S1.6. Location of MARINe Target Species and Seastar plots at Taylor Point, OLYM.

Figure S1.7. Location of MARINe Target Species and Seastar plots at Starfish Point, OLYM.

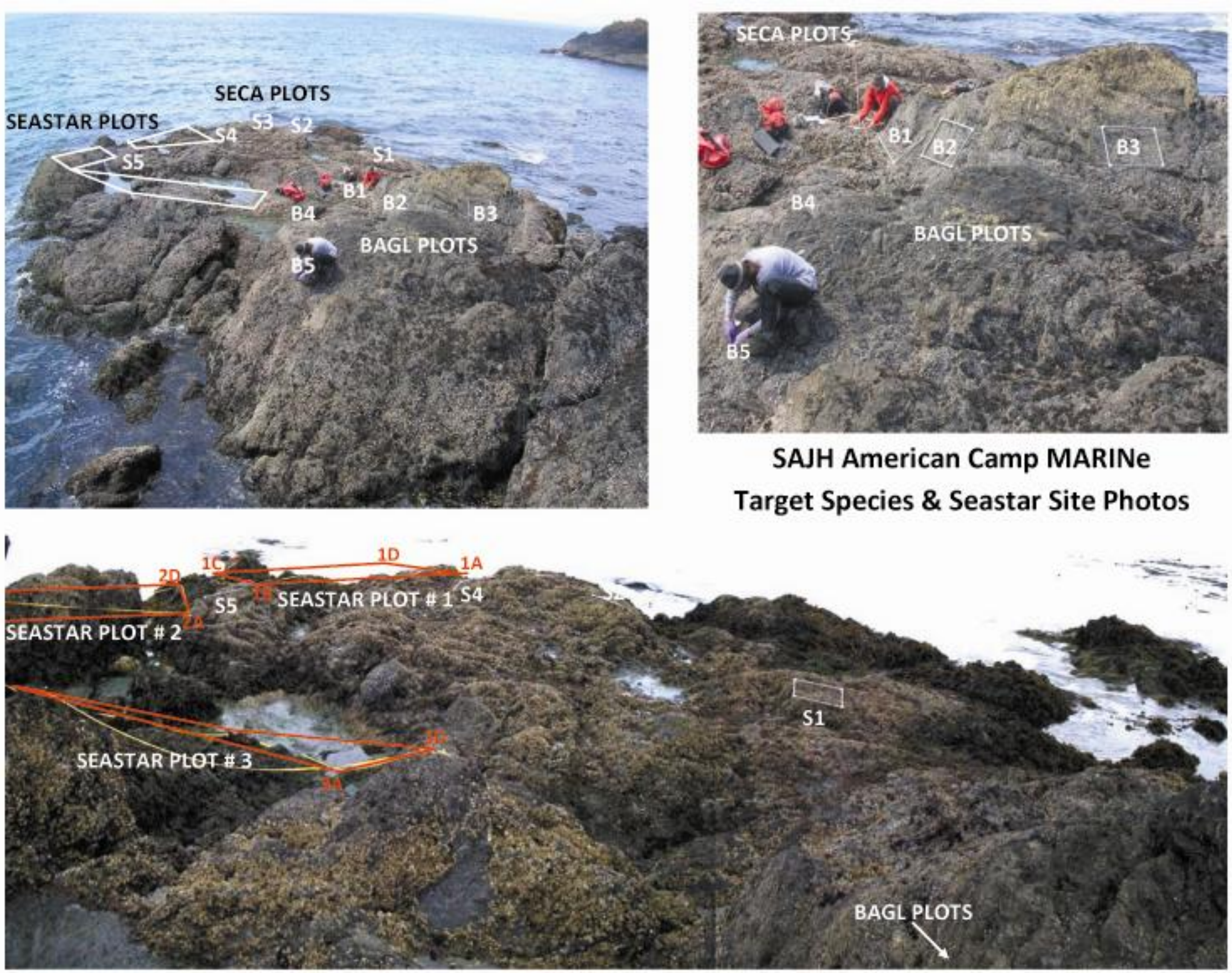

Figure S1.8. Location of MARINe Target Species and Seastar plots in the American Camp Unit of SAJH.

SAJH English Camp MARINe Target Species Sites

Figure S1.9. Location of MARINe Target Species plots in the English Camp Unit of SAJH. There are no Seastar plots at this site.

LEWI Ecola State Park MARINe Target Species Sites

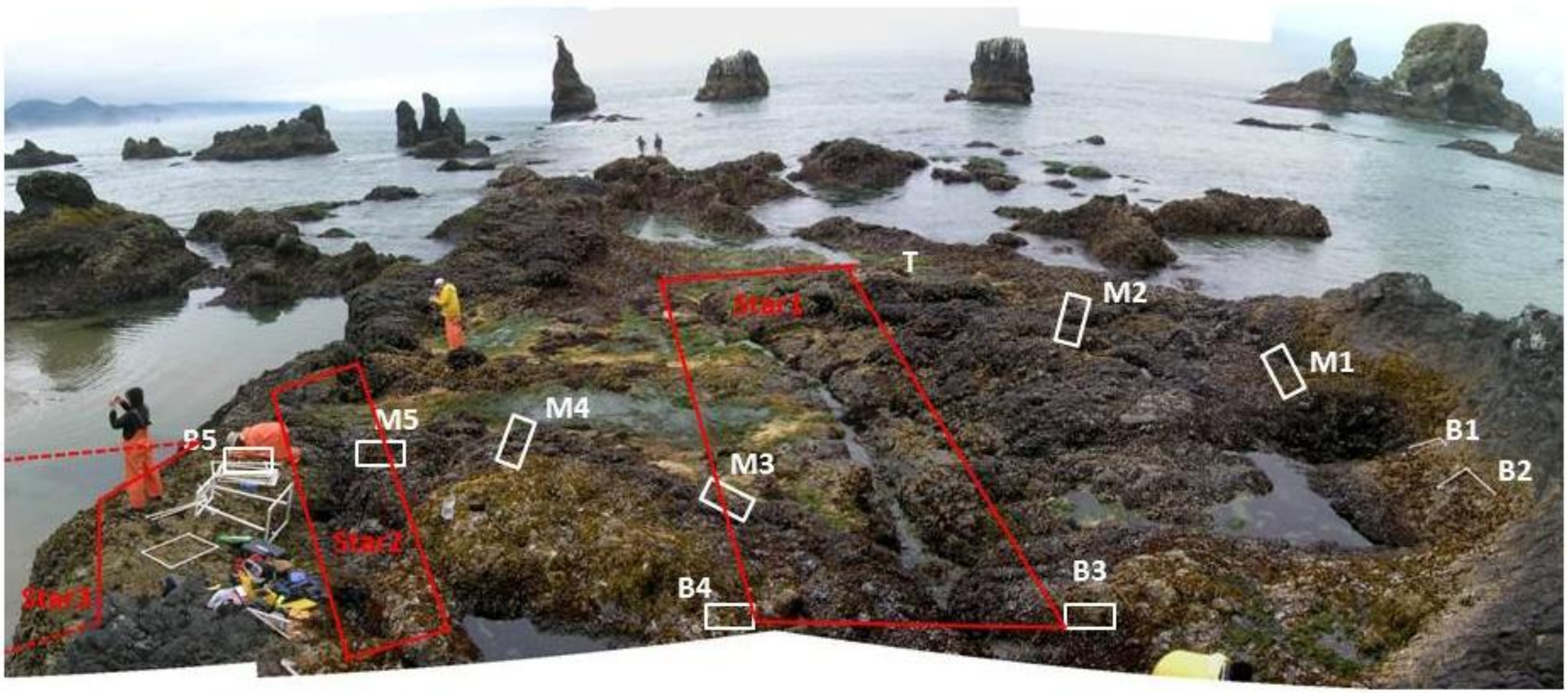

Figure S1.10. Location of MARINe Target Species and Seastar plots in the Ecola State Park unit of LEWI

Literature Cited

Ammann, K. N., and P. T. Raimondi. 2008. Long-term monitoring protocol for rocky intertidal communities of Redwood National and State Parks, California. Natural Resource Report. NPS/KLMN/NRR—2008/034. National Park Service, Fort Collins, Colorado.

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Attachment S1.1: NCCN Intertidal Field Log Form

NCCN Intertidal Field Log Version: June 10, 2010

Site: ___________________ Date:________ Time:_____ to _____ Low Tide:_____(ft) at _____(hr)

Observers:____

(Fill in all blanks.: **X**=No Data; **0**=None: **L**=Low; **M**=Med; **H**=High; **Wind**: L = ≤10 kts M = 11-20 kts H => 20

Weather and Sea Conditions (affecting quality of sampling; use codes listed above)
Swell/Surge:________ Wind:________ Rain:_______

Debris and Pollutants (magnitude at site):
Plant Wrack:_____ Driftwood:_____ Shells:______ Dead Animals:______ Trash:______ Oil/Tar:_____

Other Notes:

Task List:

Description	Task Notes	Follow-up Notes	Complete Y/N

Survey Checklist

TempLogger:___ Download___ Photos___

Sand Site:___ Transect Cores___ Elevation___ Sediments___ Vouchers___ Photos___

Marine Target Species Site:___ Field scored plots___ Photoplots___ Seastar Plots:___

Community Rocky Site:___ PointCounts:___ Quadrats:___

Site Overview: Photos____ Birds:___ Mammals:___ Humans:___ Plot Marker Repairs:___

QA/QC Check: Reviewed:__________ Entered:________ Verified:________
Date:____________ Date:__________ Date:__________

Attachment S1.1 (continued): NCCN Intertidal Field Log Form, page 2

NCCN Intertidal Field Log Version: June 10, 2010
Page 2

Photos:

Purpose	Photo #	Caption #	Description	Office Filename

QA/QC Check: Reviewed:__________ Entered:__________ Verified:__________
Date:__________ Date:__________ Date:__________

Attachment S1.2: NCCN MARINe Target Species Plot Scoring Data Form

NCCN MARINe Target Species Plot Scoring Data Sheet Version: June 10, 2010

Site:_______________ Date Sampled:____________ Assemblage________________

Scorer:______________

Core Taxa	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Balanus glandula BAGL					
Chthamalus dali CHDA					
Semibalanus cariosus SECA					
Mytilus californianus MYCA					
Mytilus trossulus MYTR					
A. elegantissima ANEL					
Pollicipes polymerus POPO					
Fucus gardneri FUGA					
FUGA on BAGL *					
FUGA on MYCA					
Endocladia muricata ENDO					
"Petrocelis" PETRO					
Mastocarpus papillatus MAPA					
Mazzaella cornucopia MACO					
Pelvetiopsis limitata PELI					
Mazzaella affinis MAAF					
Ulva/ Enteromopha ULVA					
Crustose corallines CRUST					
Non-coralline crusts NCRST					
Articulated Corallines CORAL					
Porphyra sp. PORPH					
Neorhodomela larix NELA					
A. xanthogrammica ANXA					
Dead MYCA DMYCA					
Dead MYTR DMYTR					
Dead BAGL DBAGL					
Dead CHDA DCHDA					
Dead SECA DSECA					
Pisaster ochraceus PIOC					
Limpets					
Chitons					

QA/QC Check: Reviewed:___________ Entered:_________ Verified:_________
Date:______________ Date:____________ Date:____________

SOP 2: MARINe Seastar Plots

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Jan 2009	S.C. Fradkin	---	Original
Jan 2010	S.C. Fradkin	Minor clarifications	Peer-review revisions

Introduction

Seastars are keystone predators in the intertidal and are one of the major influences that structure intertidal communities. This Standard Operating Procedure (SOP) summarizes the procedures for conducting seastar monitoring following MARINe methods that allow comparison of results within the NCCN and across the entire MARINe network (Engle 2005). Seastar monitoring will be conducted annually at each rocky shoreline site (Figures 3-5) during the summer sampling visit. Plots will be established and sampled beginning in the summer of 2009. The *Pisaster ochraceus* (Figure S2.1) is the target species for size frequency measurements. All other sea star species are enumerated when present. These species include *Pycnopodia helianthoides*, *Leptastarias hexactis*, *Henricia leviuscula*, and *Dermasterias imbricata*.

Figure S2.1. Three color morphs (purple/brown/orange left to right) of the seastar *Pisaster ochraceus* present on the outer coast of Washington.

Field Equipment Needed

- Clipboard
- Maps, directions, site photos
- Sampling protocol
- Camera
- Data sheets (Attachments S2.1)
- Field Log
- Rock Hammer Drill (for site set-up)
- Z-spar marine epoxy (for plot marking and maintenance)
- ¼” x 3” Stainless Steel Bolts (for marking corners of photo plots)
- Stiff paint scraper
- Wire brush

General Survey Conditions

Standard procedures involve intensive searching in irregular plots, checking in cracks and crevices, and carefully counting individual sea stars. Sea stars have been susceptible to a wasting disease in Southern California during warm water years. This is usually identified by missing arms with frayed, rotten tissue or just a general look of soft, rotten flesh. Any observations of diseased sea stars should be noted on the field log. The plots are irregular in shape, encompassing an area with initial high densities of sea stars. These plots are not intended to provide statistical inference to densities at an overall site, beach segment, or park shoreline. Irregular plots are marked by four or more “corner” bolts, one of which is notched with the plot number. The plots are placed in areas of high sea star density to obtain as many counts and measurements for size frequency as possible**.** Plots are surveyed during appropriate negative tides (<-1.0 ft). Brightly colored parachute cord is laid out around the plot perimeter and the entire plot is carefully searched. All observed seastars are enumerated on a datasheet. *Pisaster* are counted and measured if any part of the animal is inside the plot. *Pisaster* is the archetypal keystone predator that plays a key role in Pacific Northwest intertidal community structure (Paine 1969). Three color morphs (purple/brown/orange) are present on the Washington coast. Each sea star is temporarily marked with yellow forestry chalk to avoid duplicate counts.

Plot Selection

Three permanent plots will be established in 2009 at each of our rocky shoreline site. Plots have already been established at the LEWI rocky shoreline site by the California-based MARINe group. These judgment plots are selected based on the following considerations: 1) High initial *Pisaster* densities that suggest preferred habitat. 2) Presence of substrate characteristics (e.g. landmarks, substrate composition that retains bolts) that facilitate relocation of plots annually. 3) Location on beach segments adjacent to but not overlapping other monitoring sites. Seastars are found in exposed locations with high mussel growth that may present challenges to locating plot markers. The use of detailed maps, interplot measurements, and overview photos is necessary for locating plots. Sea star aggregations often move across the reef so that fixed plots may detect more variability than is actually present. Plot locations within OLYM, SAJH, and LEWI sites are illustrated in Figures S1.4-S1.10.

Procedures

Procedure for fixed irregular plot search for seastars

1. Locate plots. Stretch a brightly colored parachute cord around the permanent bolts to outline the perimeter of the plot.
2. The defined plot is surveyed for the presence of sea stars.
3. *Pisaster* are measured with a ruler from the center of the disc to the tip of the longest ray to the nearest 5 mm for animals <10 mm and the nearest 10 mm for larger sea stars. Often sizes have to be estimated because sea stars are wedged in tight spots with rays curved. A flashlight is used to see in cracks and overhangs. Sea stars are never “straightened” or removed from the rock.
4. The color category (Purple, Brown, or Orange) is recorded for *Pisaster*.
5. Other species of seastars are enumerated only.
6. Once recorded, seastars are temporarily marked with a forestry crayon to avoid double counting.
7. Size measurement and species are recorded directly to the **NCCN MARINe Seastar Datasheet** (Attachment S2.1). Usually one or two people search for stars and one person records measurements.
8. While still at the site, each datasheet is checked for missing information and legibility. This is best if done by someone other than the recorder. Any questions about shorthand symbols or notation should be clarified immediately with the recorder and included with the notes. Any variation to normal protocol should be noted briefly on the datasheet itself and on the daily log. Transcribe any notes made on other datasheets so that all information is kept together.

Procedure for Data Management

1. At the end of the day, while the events are still fresh, read over the datasheet, checking that the writing is legible and all parts are completely filled in. Add any other notes as appropriate.
2. File the **NCCN MARINe Seastar Datasheet** with all other datasheets from the monitoring event in the appropriate data binder.
3. At the end of the field season datasheets will be scanned into a PDF document that will be stored on the Intertidal project folder on the NCCN network. Hardcopies of the datasheets will be stored by the Project Lead.
4. Data will be exported from the NCCN database to the MARINe database annually according the schedule outlined in Chapter 4, Section K.

Deviations from MARINe Handbook Procedures

1. Single (annual) site visits are conducted rather than bi-annual site visits. The rocky shorelines of the Pacific Northwest experience daylight negative low tides only during the summer. Night-time winter low tides are too dangerous to work on the outer coast.

2. Instead of the standard MARINe procedure of classifying *Pisaster* color morphs into two categories (purple/orange), the NCCN will classify 3 color morphs (purple/brown/orange). The outer Washington coast contains 3 distinct color morphs (*sensu* Harley et al. 2006). For consistency however, the NCCN will be condensed (purple/brown converted to all purple) for export to the MARINe database.

Site Locations

MARINe Seastar plots will be conducted at each Rock component monitoring site in NCCN parks and were established in 2009. See SOP1 for site directions.

Literature Cited

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Attachment S2.1: NCCN MARINe Seastar Plot Data Form

NCCN MARINe Seastar Plot Data Form Version: June 10, 2010

Site:________________ Date: _______________

Observers: __________________

PISASTER

Size	Plot 1			Plot 2			Plot 3		
Radius (mm)	Purple	Brown	Orange	Purple	Brown	Orange	Purple	Brown	Orange
5									
10									
20									
30									
40									
50									
60									
70									
80									
90									
100									
110									
120									
130									
140									
150									
160									
170									
180									
190									
200									

Other Seastars (total # only, no sizes)

Species	Plot 1	Plot 2	Plot 3
Leptastarias hexactis			
Henricia leviuscula			
Pycnopodia helianthoides			
Dermasterias imbricata			

QA/QC Check: Reviewed:___________ Date:______________ Entered:_________ Date:___________ Verified:_________ Date:___________

SOP 3: Community Rocky Intertidal Monitoring

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Jan 2009	S.C. Fradkin	---	Original
Jan 2010	S.C. Fradkin	Minor clarifications	Peer-review revisions

Introduction

Figure S3.1. A Community Rocky Shoreline monitoring plot at Sokol Point, OLYM.

Intertidal zonation, the occurrence of distinct elevational bands of organisms, is a common feature of rocky intertidal habitats, with elevational limits based upon environmental gradients, physiological tolerances, and organismal interactions (Lewis 1964). Monitoring designs that focus on specific organismal bands at fixed elevations are commonplace (Murray et al. 2006), however, challenges exist with designs that are based on plots or transects at fixed elevations. Along the coast, particular bands often occur at different tidal elevations due to spatial variation in wave run-up caused by differences in platform aspect, angle, and exposure (Kozloff 1996). Within sites organismal bands are not expected to remain at static elevations over time. The predicted impacts of global climate change include a rise in sea level and a concomitant upward shift in species distributions (Harley et al. 2006, Helmuth et al. 2006). Thus, to adequately detect trends in the abundance and vertical distribution of rocky intertidal organisms, a monitoring design targeting dominant organismal zones must both track the vertical shift and quantify the organisms in each zone.

The objective of this SOP is to detect change in the dominant community structure, abundance and vertical distribution of sessile and weakly mobile organisms in rocky shoreline habitats. A permanent 10m wide alongshore plot composed of two “adaptive” belts running parallel to the shoreline will be established to span the high and mid intertidal zones (Figures S3.1, S3.2, S3.3).

These adaptive belts are based upon the elevational width of the dominant community band for a zone that may change over time, rather than fixed elevational heights. The high zone community is dominated by barnacles and macroalgae, while the mid zone is dominated by mussels. Zone widths will be determined based upon the elevational distribution of the dominant organisms along six vertical transects that run perpendicular to the belt transect. Random point counts and random quadrats will be used to determine the percent area coverage of sessile organisms and the abundance of weakly mobile organisms in each zone. The basic methodology for this protocol is adapted from Dethier (1997), Murray et al. (2006), and UCSC (2006).

Equipment Needed

- 2 – 50 m tapes
- 7 – 30 m tapes
- 2 – 20 cm x 20 cm pvc quadrats w/ 4pt grid
- 2 – 1 m sticks (rulers)
- A random number table
- Intertidal Field Log Data Sheet (Attachment S1.1)
- Community Vertical Zone Transect Data Sheet (Attachment S3.1)
- Community Point Contact Data Sheet (Attachment S3.2)
- Community Quadrat Data Sheet (Attachment S3.3)
- Taxonomic field guide materials
- Whirlpack bags
- Microcentrifuge tube w/ ETOH
- Rock hammerdrill
- ¼” x 3” Stainless Steel Bolts
- Z-spar marine epoxy

Procedures

<u>Monitoring Schedule</u>

Community Rock habitat sampling will be conducted in the summer months during morning low tides of sufficient elevation to allow adequate working time, generally on tides of -0.5 ft or less.

<u>Site Establishment and Maintenance</u>

1. In each OLYM nearshore cell, a shoreline segment of rocky platform habitat was chosen at random using the OLYM GIS database (adapted from Schoch 1999). This beach segment also contains a MARINe Target Species monitoring site (SOP1) and an Intertidal Temperature monitoring site (SOP5).
2. At each site a 10m wide stretch or rocky platform was chosen for the monitoring plot based on several criteria. This plot must be on a continuous area or rocky bench with a slope between 30-35° that exhibits strong zonation patterns in the high and mid intertidal zones at the time of establishment. This slope restriction constrains the sampling area width, thereby reducing the higher variability associated with patchiness on gently sloping (< 30°) rocky platforms.

3. An initial 10m temporary baseline was laid down, parallel to the shore at an approximately high elevation.
4. Six (6) vertical transects were established at the 0, 2, 4, 6, 8 and 10m marks on the temporary baseline. Meter marks are always designated from the north to the south, or alternately from the east to the west. The head of each vertical transect is surveyed and starts 2 ft in elevation above the mean higher high water (MHHW) point. Each transect extends down to 3ft below mean sea level (MSL). The top and bottom of each vertical transect have been marked by a permanent stainless steel bolt set into the rock with Z-spar marine epoxy. These bolts are used to set-up the site in subsequent years. The length of the vertical transects have been recorded in case any head/foot bolts are lost between sampling visits.
5. A meter tape is extended from the top to the bottom of each vertical transect (0, 2, 4, 6, 8 and 10 m respectively).
6. The top and bottom of the high and mid elevational zones are determined using the procedure outlined below (see Vertical Zone Determination). The top of the mid zone is always the same boundary as the bottom of the high zone.
7. Once the elevation zone boundaries are determined, 10-m tapes are laid out along the horizontal boundaries of each zone: the High zone top, the High/Mid zone boundary, the Mid zone bottom. The "zero" point of each tape will be on the left, so that tapes go consistently from left to right (see Figures S3.2 and S3.3).
8. In each subsequent site visit in future years, bolts marking the head and foot of the vertical transects are checked to ensure their integrity. This activity includes scraping away any encrusting organisms attached to the bolts or Z-spar epoxy, re-applying Z-spar epoxy when necessary to ensure bolt stability, and re-drilling/re-setting new bolts if the old bolt locations have been compromised. If new bolts are installed, the new vertical transect length will be measured and recorded on the data sheet.
9. Each bolt is photographed from multiple angles including local landmarks on each site visit so that bolts can be re-found using site photos.

Vertical Zone Determination

1. The elevational width of the High and Mid zones is determined annually upon each visit based on the vertical distribution of the target (dominant) organismal zone bands. The distribution of organisms along each vertical transects is used to determine the zone boundaries.
2. After set-up of the vertical transects, the three zone boundaries are determined for each transect. A meter stick held perpendicular and centered on the transect (½ m on either side) is tracked down the transect until 6 zone-defining organisms are encountered within the 1-m-wide cross-section. Zone boundary points (the distance along the vertical transect) are recorded on the Community Zone data sheet (Attachment S3.1).
3. The three zone boundaries on vertical transects are:
    a. High zone top: The point where macroalgae and/or barnacles appear.
    b. High /Mid boundary: The point where the shift to mussel dominance occurs (i.e. where 6 mussels occur within the 1 m cross section).
    c. Mid zone bottom: The point where mussels cease to occur
4. The zone-defining taxa are:

d. High zone: barnacles (*Balanus glandula, Chthamalus dalli*) and macroalgae (*Fucus*, *Pelvetiopsis*).
e. Mid zone: mussels (*Mytilus californianus*, *M. trossulus*).

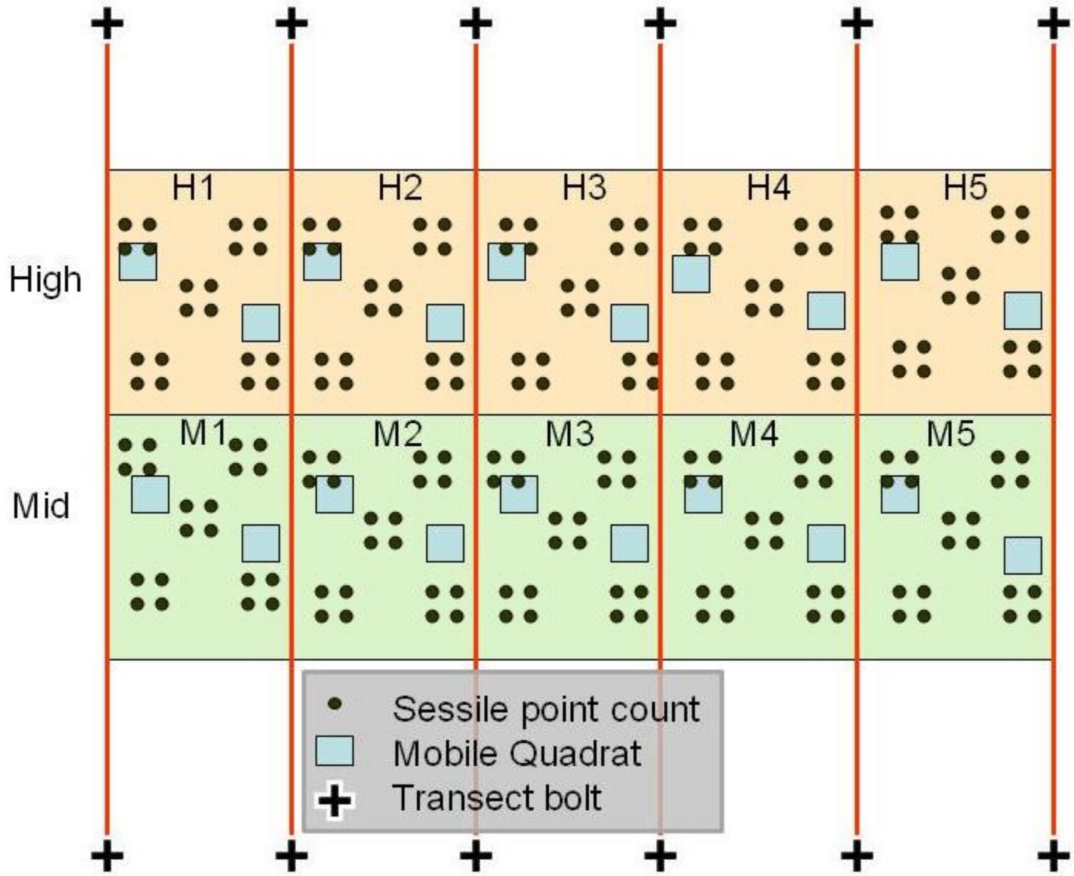

Figure S3.2. Schematic Community plot design. Each zone (high and mid) is divided into 5 panels. Each panel has 20 random point contacts (100 per zone) and 2 random quadrats (10 per zone). Point contacts estimate percent cover by sessile species and quadrats estimate abundance of weakly mobile animals. Vertical transects (red lines) use zone-defining sessile organism to define zone boundaries.

Figure S3.3. Sokol Point (OLYM) Community monitoring site illustrating typical high and mid zonation patterns. Yellow measuring tapes demarcate vertical transects and green line overlays demarcate approximate boundaries between zones.

Percent Cover of Sessile Organisms: Random Point Counts

The scoring frame is a square rectangle made of ½ " PVC pipe with glued joints finished to an inside dimension of 20 cm x 20 cm. Two lines (fishing line) are permanently affixed (knotted) and stretched at regular intervals between each dimension (up/down, side/side) creating a grid of 9 blocks of the same area and 4 points at the crossing of perpendicular lines.

1. The organisms under 100 random points in each zone (High and Mid) are used to determine the percent area cover of sessile organisms within each plot.
2. Each zone is composed of 5 – 2 m long panels, the elevational width of which can change annually depending upon the width of organism bands.
3. In each panel 20 point contacts are sampled. A random number table is used to determine a distance down the left vertical transect within each elevational zone. This distance is the location of the top left corner of the scoring frame. A random number between 0-9 is then drawn to determine the number of sample frame lengths to the right where point contacts will be sampled. For example, if the zone width in Panel H1 (see Figure S3.2) ranges from 50-200 cm along the vertical transect, and a the random distance 145 and

random number 5 are drawn, the top right corner of the scoring frame is placed at the 145 cm point on the tape and the frame is flipped side-over-side 5 times. At this resting spot, the 4 points under the scoring frame grid are surveyed. This process is repeated 4 more times for each panel, producing a total of 20 point contacts per panel and 100 point contacts per zone.

4. At each point contact, the first two unique sessile organisms found under the point will be recorded on the **NCCN Community Rocky Monitoring Point Contact Datasheet (Attachment S3.2)**. The top species will be recorded in the **Layer 1** column while the bottom species (if present and different from the Layer 1 species) will be recorded in the **Layer 2** column.
5. After sampling in a zone is completed, **all Layer 1 tallies must add up to 100**. Layer 2 tallies do not need to add up to 100.

Weakly Mobile Organism Abundance: Random Quadrats

1. The abundance of weakly mobile organisms will be determined in each zone by counting these organisms in the 20 cm X 20 cm scoring frame. Weakly mobile organisms are invertebrates capable of movement, but incapable of fleeing or hiding in the study site in response to movement by staff (i.e. chitons, snails, etc.). Highly mobile invertebrates (i.e. shore crabs, etc) cannot be accurately quantified using this method.
2. Two (2) quadrats are sampled in each panel in each zone, resulting in a total of 10 quadrats per elevational zone.
3. A random number table is used to determine a distance down the left vertical transect within each elevational zone. This distance is the location of the top left corner of the scoring frame. A random number between 0-9 is then drawn that determines the number of sample frame lengths to the right where point contacts will be sampled. For example, if the zone width in Panel H1 (see Figure S3.2) ranges from 50-200 cm along the vertical transect, and a the random distance 145 and random number 5 are drawn, the top right corner of the scoring frame is placed at the 145 cm point on the tape and the frame is flipped side-over-side 5 times. At this resting spot, all of the weakly mobile organisms within the scoring frame are identified, counted and recorded on the **NCCN Community Rocky Community Monitoring Quadrat Data Sheet (Attachment 3.3).** This process is repeated a second time in each panel.
4. In cases where the entire quadrat does not fall within the zone, a new frame location will be drawn.
5. Where organisms are super-abundant (i.e. littorinids, small black limpets, etc.), the quadrat may be sub-sampled by counting organisms in a subset of the scoring frame's 9 blocks and multiplying to extrapolate to the entire scoring frame density. In these cases the same set of blocks will be sub-sampled from frame to frame to minimize bias. For example, if littorinid densities are very high and only 4 blocks will be sampled, they will always be the 4 corner blocks.

Sampling Quality Control Considerations

1. If identification of any species is in doubt, an in-place digital photo of the organism will be taken and voucher specimen of the organism from similar habitat outside of the

sampling plot will be taken. Use either a Whirlpack bag or a microcentrifuge tube with ETOH to transport the sample back to the lab for positive identification.
2. Make sure that all datasheet information fields are filled out before leaving the site.
3. On the **NCCN Community Rocky Community Monitoring Point Contact** data sheet, sum all of the tallies under **Layer 1** for each panel and ensure that they add up to 100.
4. Check all data sheets in the field for completeness and accuracy.

Site Area Photos

Digital panoramic photos of the overall monitoring site area will be taken to provide a visual record of overall site appearance, especially gross patterns of organism distribution and abundance. A series of panoramic photos will be taken on each site visit from at least one fixed reference point and are ultimately stitched together into a single comprehensive photograph. In addition to panoramic photos, individual digital photos will be taken of any unusual or interesting phenomena, such as rock breakage, poor organism health (bleached algae, barnacle scars, etc.), intrusion of sand, obvious recruitment events, and the presence of anthropogenic impacts (oil deposits, trampling effects). Steps for taking site overview photos include:

1. Identify a reference location based upon landmarks… verify this location through the use of an initial site photograph that identifies the vantage point for the site panoramic photos. Place a small dollop of Z-spar to further mark the site. A Z-spar/landmark based location is preferable to placing a bolt in the substrate in order to reduce the number of bolts being placed in the park environment. Use the automatic setting on the digital camera. Avoid placing the sky or sea as the main focal point as it will alter the exposure quality and reduce the utility of the photograph.
2. For panoramic photos include sequential, overlapping habitat photos (i.e. "pans") taken while rotating the view area from left to right from the fixed epoxy reference point. Keep the camera level and overlap approximately 1/3 of the image in each frame.
3. Record notes on the **Intertidal Field Log Data Sheet**. Indicate number of photos in each panoramic series.

Site Locations

Communities plots have been established at the OLYM Rock Component sites (see SOP1 for site directions). UTM coordinates for plots appear below in Table S3.1.

Table S3.1. UTM coordinates for Community rocky monitoring plots in OLYM

Park	Site Name	UTM E	UTM N
OLYM	Point of Arches	373278.1	5344343.0
	Sokol Point	375951.8	5311753.3
	Taylor Point	382589.4	5302588.2
	Starfish Point	395512.3	5278671.3

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Taxonomic Keys Used for Identification and Training

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Attachment S3.1: NCCN Rocky Intertidal Community Vertical Transect Zonation Data Form

Rocky Community Vertical Transect Zonation Data Form Version: June 10, 2010

Site: ________________ Date: ________________

Observers: __________________

Zone	**Distance down Vertical Transect**					
	0 m	**2 m**	**4 m**	**6 m**	**8 m**	**10 m**
High Top						
High/Mid						
Mid Bottom						

Notes:

QA/QC Check: Reviewed:__________ Date:______________ Entered:_________ Date:____________ Verified:_________ Date:____________

Attachment S3.2: NCCN Rocky Intertidal Community Point Contact Data Form

NCCN Rocky Community Point Contact Data Form Version: June 10, 2010

Park: **Site:** **Date:**

Observers:

Taxa	Code	Panel		Panel		Panel	
		Zone		Zone		Zone	
		Layer 1	Layer2	Layer 1	Layer 2	Layer 1	Layer 2
Acrosiphonia spp.	ACROS						
Analipus japonicus	ANJA						
Anthoplerua xanthogrammica	ANXA						
Anthopleura elegantissima	ANEL						
Balanus glandula	BAGL						
Bossiella spp.	BOSSI						
Callithamnion pikeanum	CAPI						
Ceramium spp.	CERAM						
Chthamalus dalli	CHDA						
Cladophora spp.	CLADO						
Colpomenia spp.	COLPO						
Corallina spp.	CORAL						
Cryptopleura lobulifera	CRLO						
Cryptosiphonia woodii	CRWO						
Cumagloia andersonii	CUAN						
Dilsea californica	DICA						
Endocladia muricata	ENMU						
Farlowia mollis	FAMO						
Fucus gardneri	FUGA						
Gelidium spp.	GELID						
Halichondria panicea	HAPA						
Halosaccion glandiforme	HAGL						
Hedophyllum sessile	HESE						
Hildenbrandia spp.	HILDE						
Leathesia difformis	LEDI						
Lithothamnion spp.	LITHO						
Mastocarpus papillatus	MAPA						
Mazzaella cornucopiae	MACO						
Mazzaella splendens	MASP						
Microcladia borealis	MIBO						

QA/QC Check: Reviewed:__________ Entered:__________ Verified:__________
Date:__________ Date:__________ Date:__________

Attachment S3.2 (continued): NCCN Rocky Intertidal Community Point Contact Data Form, page 2

Taxa	Code	Panel		Panel		Panel	
		Zone		Zone		Zone	
		Layer 1	Layer2	Layer 1	Layer 2	Layer 1	Layer 2
Mytilus californianus	MYCA						
Mytilus trossulus	MYTR						
Neoptilota spp.	NEOPT						
Neorhodomela larix	NELA						
Odonthalia floccosa	ODFL						
Pelvetiopsis limitata	PELI						
Petrocelis	PETRO						
Plocamium tenue	PLTE						
Pollicipes polymerus	POPO						
Polysiphonia spp.	POLYS						
Porphyra spp.	PORPH						
Prionitis spp.	PRION						
Ralfsia spp.	RALFS						
Scytosiphon thersites	SCTH						
Semibalanus cariosis	SECA						
Ulva spp.	ULVA						
Verrucaria spp.	VERRU						

Notes:

QA/QC Check: Reviewed:__________ Entered:__________ Verified:__________
Date:__________ Date:__________ Date:__________

Attachment S3.3: NCCN Rocky Intertidal Community Quadrat Data Form

NCCN Rocky Community Point Contact Data Form Version: June 10, 2010

Park: **Site:** **Date:**

Observers:

Taxa	Taxon Code	Panel:	Panel:	Panel:	Panel:	Panel:
		Zone:	Zone:	Zone:	Zone:	Zone:
		Quad:	Quad:	Quad:	Quad:	Quad:
		Tally	Tally	Tally	Tally	Tally
Amphiporus spp.	AMPHI					
Emplectonema gracile	EMGR					
Idotea spp.	IDOTE					
Katherina tunicata	KATU					
Lepidozona/Lepidochiton	LEPID					
Leptasterias hexactis	LEHE					
Littorina spp.	LITTO					
Lottia Pelta	LOPE					
Lottia strigatella/digitalis	LODI					
Mopalia lignosa	MOLI					
Mopalia muscosa	MOMU					
Nucella canaliculata	NUCA					
Nucella lamellosa	NULA					
Nucella osterina	NUOS					
Pagurus caurinus	PACA					
Pagurus granosimanus	PAGR					
Pagurus hirsutiusculus	PAHI					
Pagurus samuelis	PASA					
Pisaster ochraceus	PIOC					
Small black limpets	SBL					
Tectura scutum	TESC					
Tegula funebralis	TEFU					

QA/QC Check: Reviewed:__________ Entered:_________ Verified:_________
Date:____________ Date:__________ Date:__________

SOP 4: Sand Beach Monitoring

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Jan 2009	S.C. Fradkin	---	Original
Jan 2010	S.C. Fradkin	Minor clarifications	Peer-review revisions
Jan 2012	S.C. Fradkin	Modified organism key	Need for additional species

Introduction

This SOP describes the methodology used to monitor the infaunal invertebrate communities of dissipative fine sand beaches in the NCCN. These beaches are dominant habitat types in most NCCN marine parks and play an important role in nearshore zone nutrient recycling, as well as providing key resources to migrating birds. Sand beaches are particularly susceptible to climate change, shoreline modification and oil spills. In this SOP, 3 random transects are established annually on each target beach segment. Each vertical transect is 60 m long perpendicular to the beach starting at the most recent high tide line, with sampling stations spaced every 7.5 m along a transect. At each station 4 sediment cores are extracted and passed through a fine sieve to retain all infaunal organisms. All organisms commonly encountered are counted and identified to the appropriate taxonomic level in the field. Voucher specimens from a single transect are collected for verification of taxonomic identification in the laboratory. Rare, anomalous or previously unobserved organisms are noted and voucher specimens are collected for laboratory identification. If these organisms occur in substantial abundances, they are enumerated on datasheets. Profiles of each transect are surveyed, and sediment samples from each station are collected to determine substrate composition. Substrate composition and beach profile data are used to confirm that beaches remain dissipative and find-sandy over time. Changes away from fine-sand, dissipative characteristics can be used to interpret infaunal community composition and species abundance trends. Reflective beaches (steeper profiled beaches that reflect wave energy) and coarse sand/gravel beaches host very different, depauperate and sparse infaunal communities (McLachlan and Brown 2006). This design is modified from Dethier (1997).

Equipment Needed

- Clipboard
- Maps, directions, site photos
- Sampling protocol
- Species Picture Identification Key
- Data sheets: 3 species forms, 3 beach profile forms
- 30 Eppendorf tubes w/ ethanol
- 3 zip-lock bags labeled for each transect’s collected eppendorf tubes
- 2 Large heavy duty plastic bags (for transporting sand sample bags)
- 12 1-quart plastic bags, labeled for sand samples

- 1 PVC core sampler
- Core Splitter
- 2 Sieves w/ 1mm mesh
- 2 Tubs for sifting
- 20 Yellow flags
- 3 Measuring tapes (2-30m and 1-50m)
- 'Expensive Pack': waterproof case for camera
- GPS
- Sharpies and pencils
- 2 Forceps
- Camera
- Elevation gear
- Laser Auto-leveler
- Laser target
- Black target mount
- Eureka rod (tent poles with 2 cinch ties)
- Orange pony clip
- Measuring tape attached to target mount (with feet – white)
- Extra batteries: 4 AA (camera), 4 AA (GPS), 4 D (leveler), 9V (target), 2 AAA (palm pilot)

Procedures

Monitoring Schedule

Sand Beach sampling is conducted in the summer months during morning low tides of sufficient elevation to allow adequate working time, generally on tides of +1.0 ft or less.

Transect Selection

1. Each target beach has been mapped into a GIS layer, with the linear along shore distance of each beach determined.

2. Prior to going into the field, ten transect locations on each beach are randomly selected using a random number generator (i.e., function in Microsoft Excel). The transect location selected is the distance (m) down the beach from the fixed northernmost starting point. This point is converted into a UTM coordinate so that transects can be identified in the field via a handheld GPS unit.

3. Once a transect is laid out (see below), a set of cores is taken directly below the transect tape to determine whether it is a valid transect. Fine sand beaches can have short sections where coarse sediments (gravel) accumulate due to hydrodynamic properties of the beach. These areas represent a very different habitat type, supporting a depauperate infauna that is not comparable to the infauna found in fine sands. Greater than 60% of the station cores on a transect must consist of fine sand to be considered valid. If a transect is

considered invalid, a new random transect location will be used from the list of 10 potential random sites.

Transect Layout

1. Once a transect location is identified, a 60 m long transect is established perpendicular to the shoreline beginning from the most recent high tide line (as determined by the wrack line).

2. A meter tape is laid out perpendicular to the shoreline starting at the most recent high tide line (Figures S4.1 and S4.2).

3. Every 7.5 m along the transect a flag is placed in the sand to mark the sampling station.

Infaunal Sampling

1. At each elevational station 4 cores are extracted using a 10 cm diameter PVC coring device inserted to a depth of 10 cm. Each replicate core is extracted at a distance of 0.5 m and 1 m from either side of the transect line (see Figure S4.2). In the event that a core is incomplete, another core can be taken next to the aborted core.

2. Each core is passed through a 1 mm Tyler sieve. The core is placed into the sieve and held halfway into a tub filled with seawater. Gentle agitation causes the sand to pass through the sieve leaving all organisms exposed.

3. All organisms are counted, identified to the appropriate taxonomic level (see Picture Key in Figure S4.3), and recorded on the **Sand Community Data Sheet** (Attachment S4.1).

4. Unknown organisms are preserved in ethanol and taken to the lab for identification.

5. Representative voucher specimens from each taxon identified on each transect are preserved in ethanol (3 individuals of each taxon per microcentrifuge tube) for laboratory identification to verify accuracy of field identifications.

Figure S4.1. An example of a sand transect layout at Second Beach, OLYM.

Sediment Sampling

1. Sediment samples are taken along each transect to determine sediment size composition. These data are primarily used to determine whether beach sediment composition is changing over time.

2. Cores are extracted from the leftmost “A” site (Figure S4.2) at the 15, 30, 45, and 60 m stations of each transect.

3. Sediment cores are “halved” using a plastic splitting device that inserts into the core to allow removal of half its contents. A whole core is extracted, laid on its side, and the splitting device is inserted into the corer, and then folded over half of the core to retain it while the other half is deposited into a plastic bag.

Sediment Processing

Drying

1. Sediment samples will be transported to the lab where they will be dried (~ hrs at 35 ºC in a drying oven).

2. Plastic bags with wet sand are pour onto individual white drying trays.

3. Drying trays are dual labeled with the appropriate site and station, by writing on the side of the tray with a sharpee and by inserting a paper label into the drying sand.

4. Approximately every other day, stir sand metal spoon to fully aerate sand to facilitate drying.
5. Dry for about 1 to 1.5 weeks. Sand must be completely dry before weighing.

6. Place dried sand in labeled Ziploc and store until weighing.

Composition Analysis

1. Samples will then be placed in a column of graded Tyler sieves (26.52, 13.2, 6.7, 3.35, 2.00, 0.850, 0.425, 0.212, and 0.106 mm) and shaken on a Rotap Shaker for 3 minutes.

2. Each sediment fraction will then be removed from the sieve with a brush and weighed using an analytical balance to determine the size fraction composition of the sample.

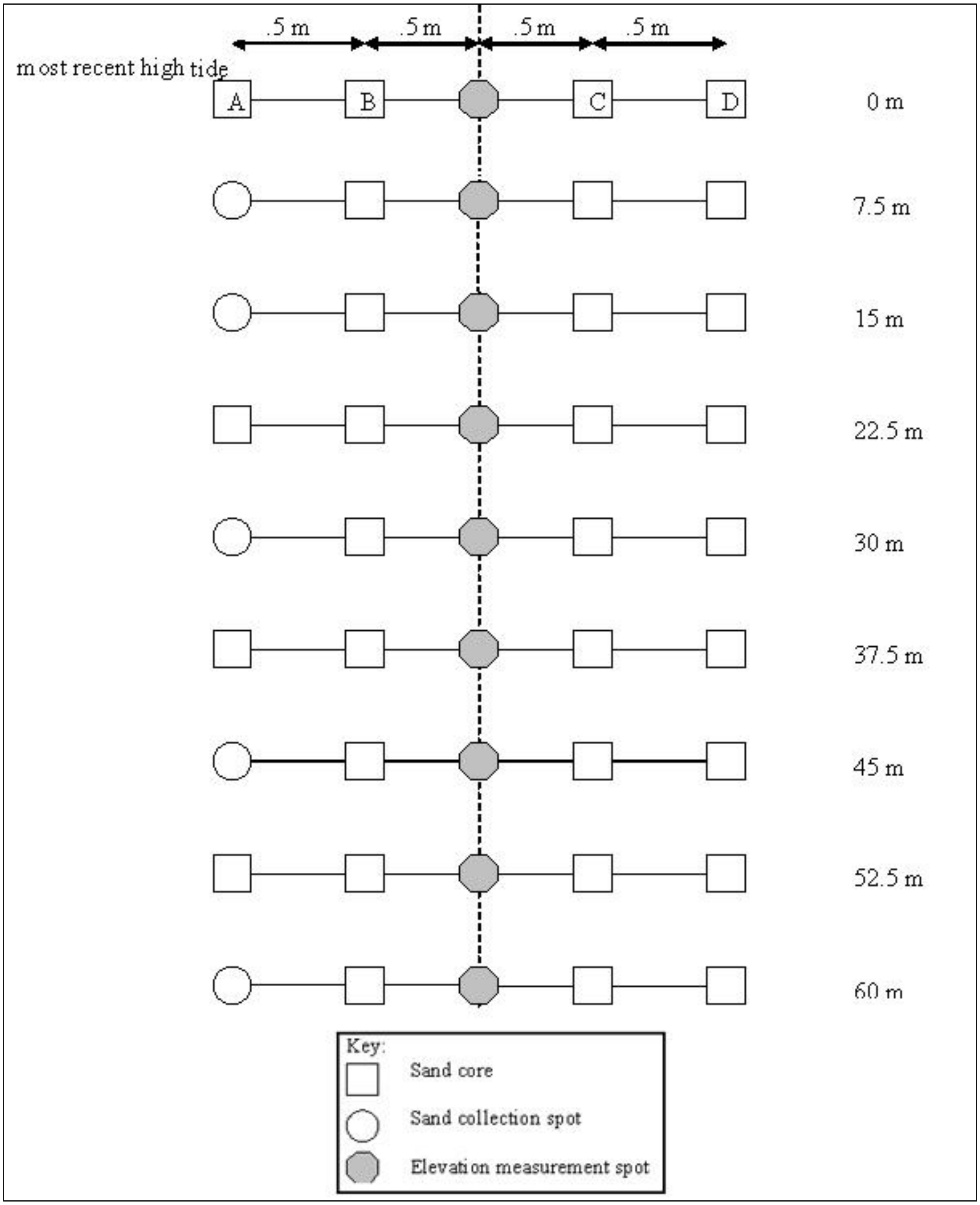

Figure S4.2. Schematic diagram of a sand beach monitoring transect.

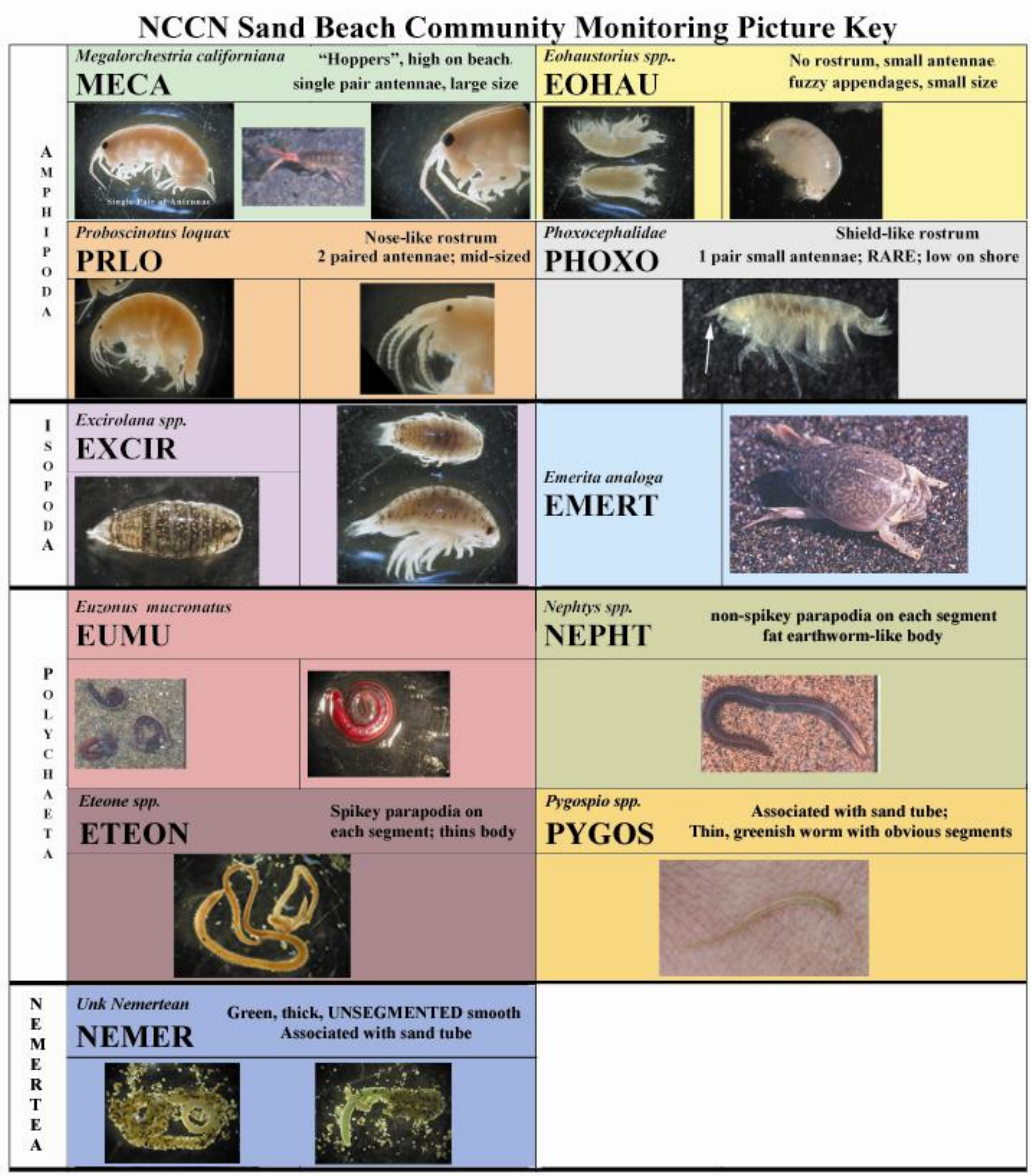

Figure S4.3. Photographic key of all infaunal sand taxa to be identified in the Sand Beach Monitoring SOP. These are the dominant taxa encountered on NCCN sand beaches. Other taxa are rarely encountered in the upper and mid intertidal zones.

Elevation Measurements

1. The beach elevational profile along each transect will be surveyed to determine the beach slope for comparison between transects and across years. Beach slope determines whether a beach is dissipative or reflective of wave energy, which is a major determinant of sediment composition. Additionally, beach elevation is a major factor structuring zonation patterns in sand beach infauna.

2. A laser auto-level will be set up at the 0 m station-- the most recent high tide line (Figure S4.4). Sand can disrupt the battery connections on the bottom of the auto-level, so the auto-level should be placed on an equipment bag/stuff sack.

3. To measure elevation, a laser target will be attached to the top of a telescoping tent pole using a large pony clip and a target mount. A measuring tape running from the target to the ground will be attached to the pony clip. The target will then be raised and lowered by extending/retracting the tent poles until the laser target audio cue signals that the target is at the height of the auto-level. The height of the target from the ground will be measured and recorded on the Beach Elevation Data Sheet.

4. The elevation of each sampling station will be measured, as will the elevation of the average tide height at the survey time. From these data and the calculated tide height at the survey time, a transect profile will be constructed and beach slope will be determined.

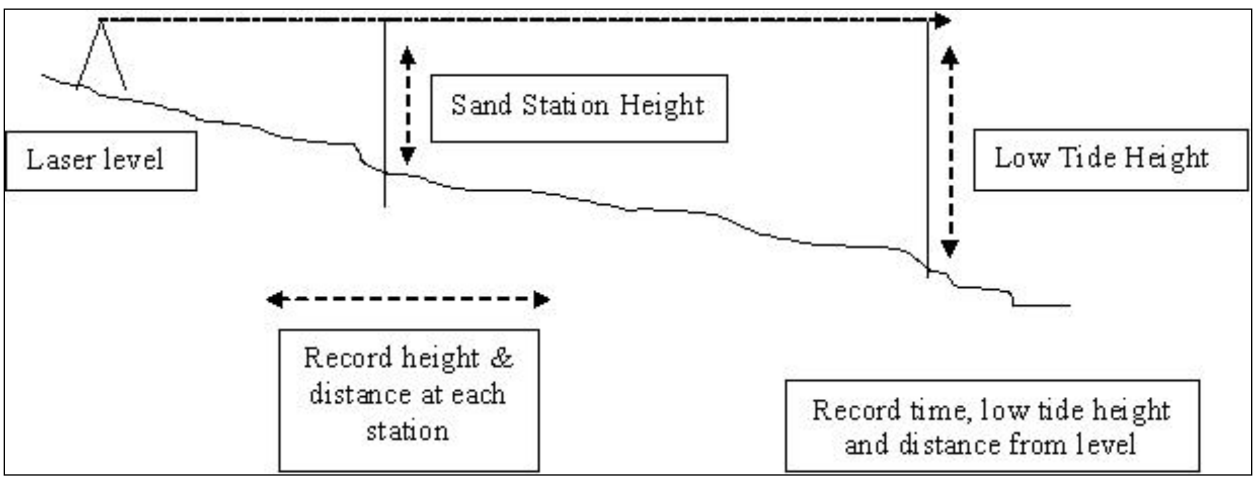

Figure S4.4. Schematic diagram of profile survey measurements for a sand transect.

Site Descriptions and Directions

Sand beach segment coordinates for sampled beaches appear in Table S4.1.

Table S4.1. UTM coordinates for the northern terminus of each target sand beach segment selected as target sites. Three sample transects in the beach segment are randomly determined each year at distances from these points.

Park	Site Name	UTM E	UTM N
OLYM	Shi Shi	375346.5	5348080.9
	Sand Point	372686.1	5331639.7
	Cedar Creek	374474.6	5319621.4
	Second Beach	378226.4	5305561.2
	Toleak Point	384804.2	5298996.7
	Steamboat Creek	393902.8	5284377.9
	Kalaloch Beach	396086.3	5276484.0

Directions Sites:

OLYM Sites: Site access at OLYM requires both drive time and hiking time. Depending upon the timing of tides, driving and/or hiking to sites with overnight camping may be required.

Shi Shi
The hike: 3 miles from Makah trailhead parking lot, along muddy coastal trail.
The drive: (same as Point of Arches temperature datalogger) ~ 2 hours from Lake Crescent Lab. Drive to Neah Bay - through town on Hwy 112. Follow signs to Fish Hatchery, stay to the right. If staying overnight, park at the house ($10) at the top of the hill.

Sand Point
The hike: 3 miles over boardwalk on southern arm of Ozette triangle trail, or 3 miles from Cape Alava over mixed-coarse beach.
The drive: (same as Ozette River/Cannonball Island loggers) about 1 ½ hours from lab. Take Hwy 112 west, follow signs for Lake Ozette.

Cedar Creek
The hike: from Rialto Beach, about 7 miles over mostly rock with some cobble stretches; 2 headlands w/ no overland trail.
The drive: (same as Sokol Point loggers) about 1 ½ hours from lab to Rialto Beach. Take Hwy 101 west. Turn right on LaPush Road. Turn right on Mora Road, follow to end. Park in backpacking/overnight lot.

Toleak South
The hike: from Third Beach trailhead, about 5 miles to campsites at Scott's Creek, 7 to campsites at Toleak South; muddy overland trails w/ rope ladders and sandy beach, Giant's Graveyard is 4.5 ft tide.
The drive: (same as Taylor Point/Goodman Creek loggers) about 1 hour from lab to Third Beach. Take Hwy 101 west. Turn right on La Push Rd, trailhead on the left.

Second Beach
The hike: 0.8 miles on turnpike.
The drive: about 1 hour from lab. Take Hwy 101 west. Turn right on La Push Rd.

Steamboat Creek
The hike: down headland on beach trail 6, Kalaloch.
The drive: about 1 ½ hours on Hwy 101.

Kalaloch
The hike: down headland on side of road between beach trails 2 and 3 (not a trail, so much as a climb down).
The drive: about 1 ½ hours on Hwy 101.

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McLachlan, A. and A. C. Brown. 2006. The ecology of sandy shores, 2n edition. Academic Press. Burlington, MA.

Taxonomic Keys Used for Identification and Training

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Kozloff, E. N. 1996. Marine invertebrates of the Pacific Northwest. University of Washington Press, Seattle, WA. 690 pp.

Morris, R. H., D. P. Abbott, and E. C. Haderlie. 1980. Intertidal invertebrates of California. Stanford University Press, Stanford, CA. 690 pp.

Attachment S4.1: NCCN Intertidal Sand Community Data Form

NCCN Intertidal Sand Community Data Form Version: June 10, 2010

Park: **Site:** **Transect:** **Date:**____________

Observers: **UTME:** **UTMN:**

Station ______	Core **A**	Core **B**	Core **C**	Core **D**
EOHAU				
MECA				
PRLO				
PHOXO				
EMERT				
EXCIR				
EUMU				
NEPHT				
UNK				
Station ______	**A**	**B**	**C**	**D**
EOHAU				
MECA				
PRLO				
PHOXO				
EMERT				
EXCIR				
EUMU				
NEPHT				
UNK				
Station ______	**A**	**B**	**C**	**D**
EOHAU				
MECA				
PRLO				
PHOXO				
EMERT				
EXCIR				
EUMU				
NEPHT				
UNK				

Notes:

QA/QC Check: Reviewed:__________ Date:__________ Entered:__________ Date:__________ Verified:__________ Date:__________

Attachment S4.2: NCCN Intertidal Sand Beach Profile Data Form

NCCN Intertidal Sand Beach Profile Data Form Version: June 10, 2010

Park:	Site:	Transect:
	UTME:	UTMN:
Observers:		Date:

Measured Tide Level in FEET

Time: Station used for tide ht:

Ht at water level:

Elev. of Measured Tide:

Station	Height in ft.	**Elev.**	Station	Height in ft.	**Elev.**
0		0			0
7.5		0			0
15		0			0
22.5		0			0
30		0			0
37.5		0			0
45		0			0
52.5		0			0
60		0			0
		0			0
					0

Invalid Transects

UTME	UTMN	UTME	UTMN

QA/QC Check: Reviewed:___________ Date:______________ Entered:_________ Date:___________ Verified:_________ Date:___________

Attachment S4.3: NCCN Intertidal Sand Composition Lab Analysis Data Form

NCCN Intertidal Sand Composition Lab Analysis Data Form Version: June 10, 2010

Park: Site: Transect

Observers Date:

Elevation

Screen Opening (mm)	Weight of beaker (grams)	Weight of sand with beaker (grams)
26.52		
13.2		
6.7		
3.35		
2		
0.85		
0.425		
0.212		
0.106		
<0.106		
TOTAL		

Elevation

Screen Opening (mm)	Weight of beaker (grams)	Weight of sand with beaker (grams)
26.52		
13.2		
6.7		
3.35		
2		
0.85		
0.425		
0.212		
0.106		
<0.106		
TOTAL		

Elevation

Screen Opening (mm)	Weight of beaker (grams)	Weight of sand with beaker (grams)
26.52		
13.2		
6.7		
3.35		
2		
0.85		
0.425		
0.212		
0.106		
<0.106		
TOTAL		

Elevation

Screen Opening (mm)	Weight of beaker (grams)	Weight of sand with beaker (grams)
26.52		
13.2		
6.7		
3.35		
2		
0.85		
0.425		
0.212		
0.106		
<0.106		
TOTAL		

Comments:

QA/QC Check: Reviewed:__________ Entered:__________ Verified:__________
Date:__________ Date:__________ Date:__________

SOP 5: Intertidal Temperature

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Jan 2009	S.C. Fradkin	---	Original
Jan 2010	S.C. Fradkin	Minor clarifications	Peer-review revisions
Jan 2012	S.C. Fradkin	Site figures added	To provide directions to sites

Introduction

Temperature is a dominant factor in determining physiological rates, tolerances and interactions of intertidal organisms. Because these organisms are alternately exposed and inundated by seawater, both water and exposed surface temperature regimes are important in structuring intertidal communities (Helmuth et al. 2002, Menge et al. 2008). Seawater and exposed temperature are both predicted to be affected by global climate change (Harley et al. 2006). This SOP describes the method for continuously monitoring seasonal and inter-annual temperature patterns in both water and on exposed rock surfaces in the mid-intertidal zone using an array of temperature data loggers. While individual taxa can differ markedly in their exposed thermal dynamics, due to difference in surface characteristics, color, adaptive cooling mechanisms etc., exposed temperature as measured by passive temperature dataloggers serves as a neutral proxy of the ambient exposed temperature conditions.

Equipment needed

- Optic shuttle and coupler (for downloading)
- extra backup Tidbit (make sure previous setting = 1 measurement/30 min)
- epoxy (equal amounts of both substances; black and yellow)
- 2 plastic coverings (cut to size with holes drilled in it)
- 2 foam pads (cut to size with holes drilled in it)
- clippers to cut the plastic covering in the field
- rock drill with 2 charged batteries and the ¼” x 6.25” DeWalt drill bit
- chisel
- at least 4 extra stainless steel (1/4” x 3” lag), washers (1/4” x 1”), and plastic anchors
- socket wrench (check socket size = 7/16)
- updated site photos with GPS coordinates
- field forms and equipment list in a Ziploc
- GPS (with logging road maps if necessary) in Ziploc
- paper topographic maps and logging road maps in a Ziploc
- camera with spare batteries
- notebook + pencil
- gate keys (if taking logging roads)

- radio plus laminated card w/ channel IDs
- updated driving directions sheet

Temperature Monitoring Site Locations

Intertidal temperature is monitored at 8 sites in OLYM (Brown's Point, Cannonball Island/Cape Alava, Goodman Creek, Norwegian, Point of Arches, Sokol Point, Starfish Point, Taylor Point); 1 site in LEWI (Ecola State Park), and 2 sites in SAJH (American Camp and English Camp units) (Figures 3-5 in **Chapter 1: Background and Objectives**). Site access and relocation is facilitated using both GPS and detailed site photos (Figures S5.3-S5.14).

Procedures

Intertidal temperature is recorded using StowAway Tidbit temperature dataloggers (Onset Co.), enclosed in a protective housing designed to alleviate direct wave force action. Dataloggers are downloaded annually during daylight summer negative low tides on days when the ocean swell is minimal. The battery life of an individual datalogger is approximately 5 years; however any particular datalogger will only be used for 4 years. After the 4th year of service, a new datalogger will be installed. New dataloggers are programmed in the laboratory to record temperatures in °C every 30 minutes. Once deployed in the field, dataloggers are triggered to start recording using a base-station coupler. Data are downloaded in the field to a StowAway Optic Shuttle with a Tidbit Coupler (Onset Co.) and transported back to the laboratory, where they are verified and uploaded to the project database. In the event of an obvious datalogger failure (i.e. data with temperature ranges beyond possible limits), suspect data are flagged and removed from the database for further consideration. The shuttle takes approximately 6 minutes to download the annual data and each shuttle can carry up to 4 different Tidbit data sets (i.e. monitoring sites).

<u>Datalogger Housing Design</u>

A "Chiton" design (Figure S5.1) was developed to protect the logger's communication LED ports and to attach the logger securely to rocky substrate. While the housing may buffer temperature changes slightly, the response delay is shorter than the instrument 5 minute response time and is much shorter than the 30 minute time scale resolution employed. The logger is encased in Z-Spar marine epoxy and covered by a foam pad layer and a plastic sheet that is removed annually for data collection. The entire apparatus is attached to the rock substrate via two bolts, one of which directly attaches the datalogger to the substrate. Datalogger access, downloading, replacement and maintenance takes approximately a half hour under normal field conditions.

Figure S5.1. A typical field installation of the "Chiton" temperature datalogger design**.**

Datalogger Programming

New dataloggers are programmed in the laboratory using the Tidbit Boxcar Pro program to record temperatures every 30 minutes. Dataloggers are set in Delayed Start mode for triggering in the field. Once deployed in the field, dataloggers are triggered to start recording using a base-station coupler.

Site Installation

1. Temperature dataloggers are installed on rock platform substrates at +2.5 ft elevation. Elevations are surveyed using the method described in **SOP 4: Sand Beach Monitoring**.
2. Prepare the site for temperature data logger installation. Remove all algae, barnacles, and epoxy in the area using the chisel and steel brush. When maintaining a site, bolts are frequently covered with epoxy, so make sure to remove all epoxy on the bolts to avoid stripping them.
3. Trigger the datalogger to start recording data.
4. Drill two holes in the rock to accommodate two bolts.
5. Mix up a small amount of epoxy, using a 1:1 mixture until it turns an olive green. Ram a short roll of epoxy into both holes and place a plastic sheetrock anchor into the holes. Wet gloves/hands with salt water before touching the epoxy to prevent sticking and to make the mixing process easier.
6. Assemble the bolts, washers, plastic protection, foam pad, Tidbit, and epoxy as shown in Figure S5.2 below. Bolts do not penetrate the Tidbit. Plastic protection and foam pads are pre-drilled and test assembled prior to deployment in the field.
7. Screw this assembly into the holes and tighten bolts until the plastic covering bends due to the resistance from the Tidbit. The epoxy should be bulging out from under the plastic.
8. Smooth the epoxy down at an angle to create a low profile… the finished assembly resembles a large chiton.

Downloading and Site Maintenance

1. When revisiting a previously deployed datalogger to download, remove the bolts, plastic sheet, foam pad, and any epoxy around the edges that is holding these items in place.
2. Data are downloaded in the field to a StowAway Optic Shuttle with a Tidbit Coupler.
3. Wipe the logger surface with a non-abrasive cloth, if necessary, to ensure that the logger's communication LEDs are clean and dry.
4. Attach the coupler to the base station, then insert the coupler over the logger with the communication LEDs facing into the coupler. When properly seated, the logger should be nearly flush with the top of the coupler.
5. Press the download button and wait for downloading to finish. During the downloading, the transfer light should flash. Upon successful downloading, the green "OK" light on the shuttle should flash. If a red light flashes, attempt the download process again. The shuttle takes approximately 6 minutes to download the annual data and each shuttle can carry up to 4 different Tidbit data sets (i.e. monitoring sites).
6. The downloading process automatically restarts the datalogger to start recording new information for the next annual cycle.

7. The data shuttle is then transported back to the laboratory, where data are verified and uploaded to the project database.
8. Reassemble the Chiton housing following steps 4-7 of the Site Installation Procedure above, making sure to **use brand NEW bolts.** The removal of the old bolts can weaken them and cause them to snap upon further removals. If the foam or plastic coverings show signs of excessive wear, replace these items.

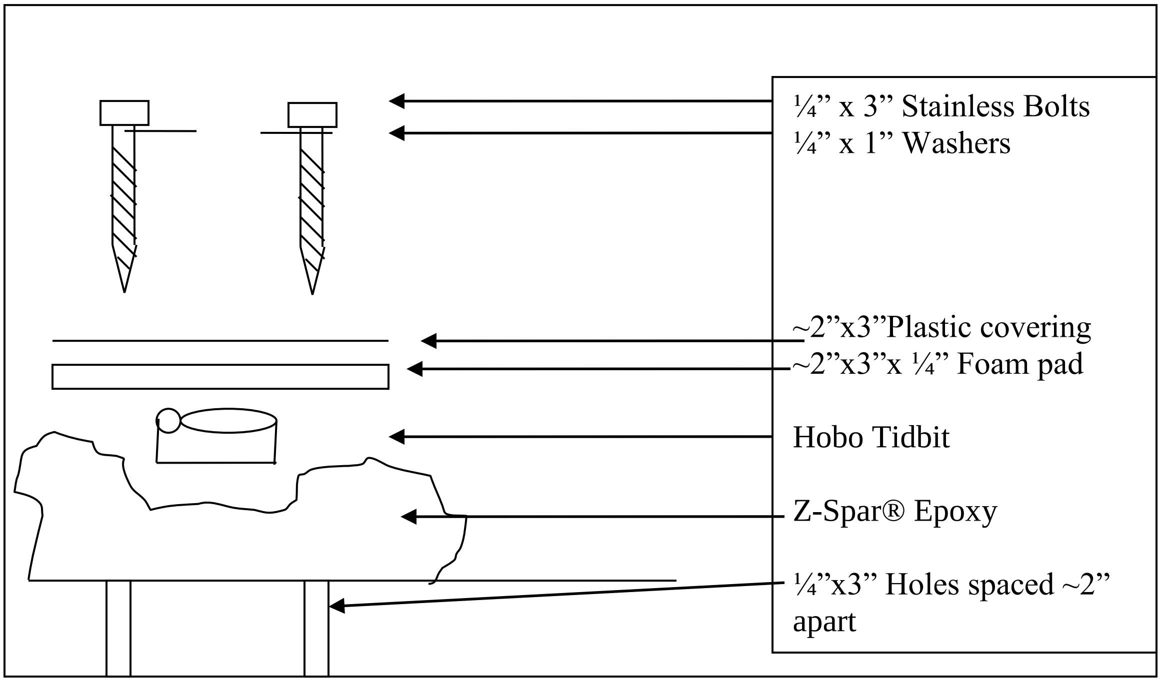

Figure S5.2. Blow-up construction diagram of “Chiton” Tidbit datalogger housing.

<u>Intertidal Temperature Data Processing</u>

Intertidal organisms are inundated and exposed regularly by tides, thus these organisms are influenced by both water and air temperatures (Helmuth et al. 2002, Menge et al. 2008). Temperature dataloggers reliably measure water temperature (Menge et al. 2008). Temperatures measured by exposed dataloggers serve as a proxy for the thermal environment experienced by the general intertidal organism, with the caveat that many specific taxa have behavioral and structural strategies for mitigating their ambient thermal environment (Helmuth et al. 2002).

Data collected by NCCN intertidal dataloggers will be processed to parse out inundated and exposed datalogger temperatures. Briefly, tidal elevations will be computed for each measured time/temperature record using NOAA tide charts. These data will then be ‘de-tided’ by separating records into inundated and exposed groups. Daily average water temperatures will be calculated from the mean of all inundated measurements during a 4 hr interval centered around each high tide (Sanford and Menge 2007). Daily exposed temperatureswill be calculated from the mean of all exposed measurements during a 2 hr interval centered around each low tide lower than mean sea level (MSL). Given daily, seasonal and annual variation in elevation of low tides, not every low tide will expose temperature dataloggers. Tides lower than MSL will ensure accurate exposure records. These tides are also the most ecologically significant, since these are the tides that allow significant warming of intertidal organisms. A program that processes datalogger files is currently being developed to automate this process.

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Helmuth, B. S., C. D. G. Harley, P. Halpin, M. O'Donnell, G. E. Hofmann, and C. Blanchette. 2002. Climate change and latitudinal patterns of intertidal thermal stress. Science 298:1015-17.

Menge, B. A., F. Chan, and J. Lubchenco. 2008. Response of a rocky intertidal ecosystem engineer and community dominant to climate change. Ecology Letters 11:151-162.

Sanford, E., and B. A. Menge. 2007. Reproductive output and consistency of source populations in the sea star *Pisaster ochraceus*. Marine Ecology Progress Series 349:1-12.

Figure S5.3. Location of the temperature datalogger at Brown's Point, OLYM.

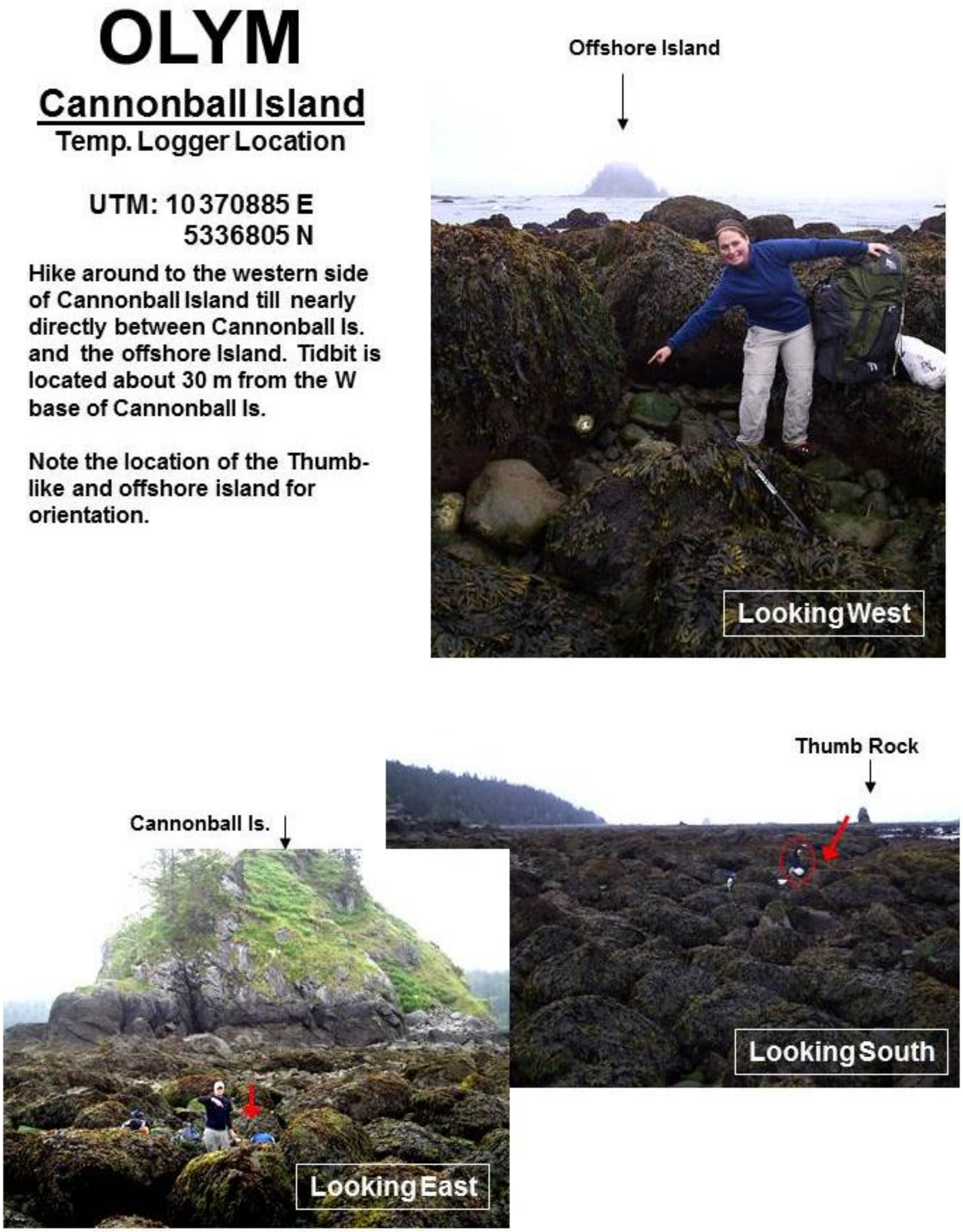


Figure S5.4. Location of the temperature datalogger at Cannonball Island (Cape Alava), OLYM.

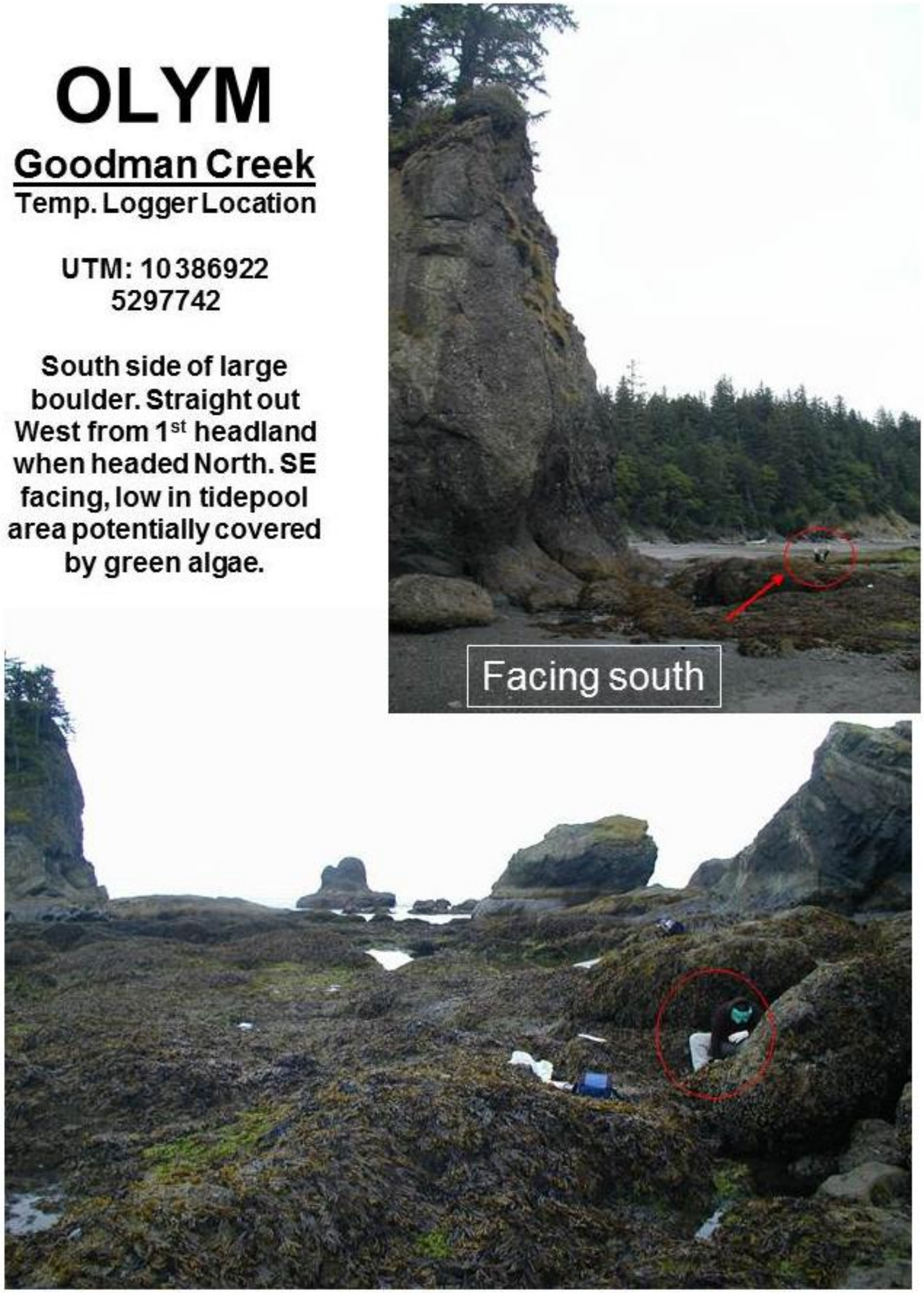


Figure S5.5. Location of the temperature datalogger at Goodman Creek, OLYM.

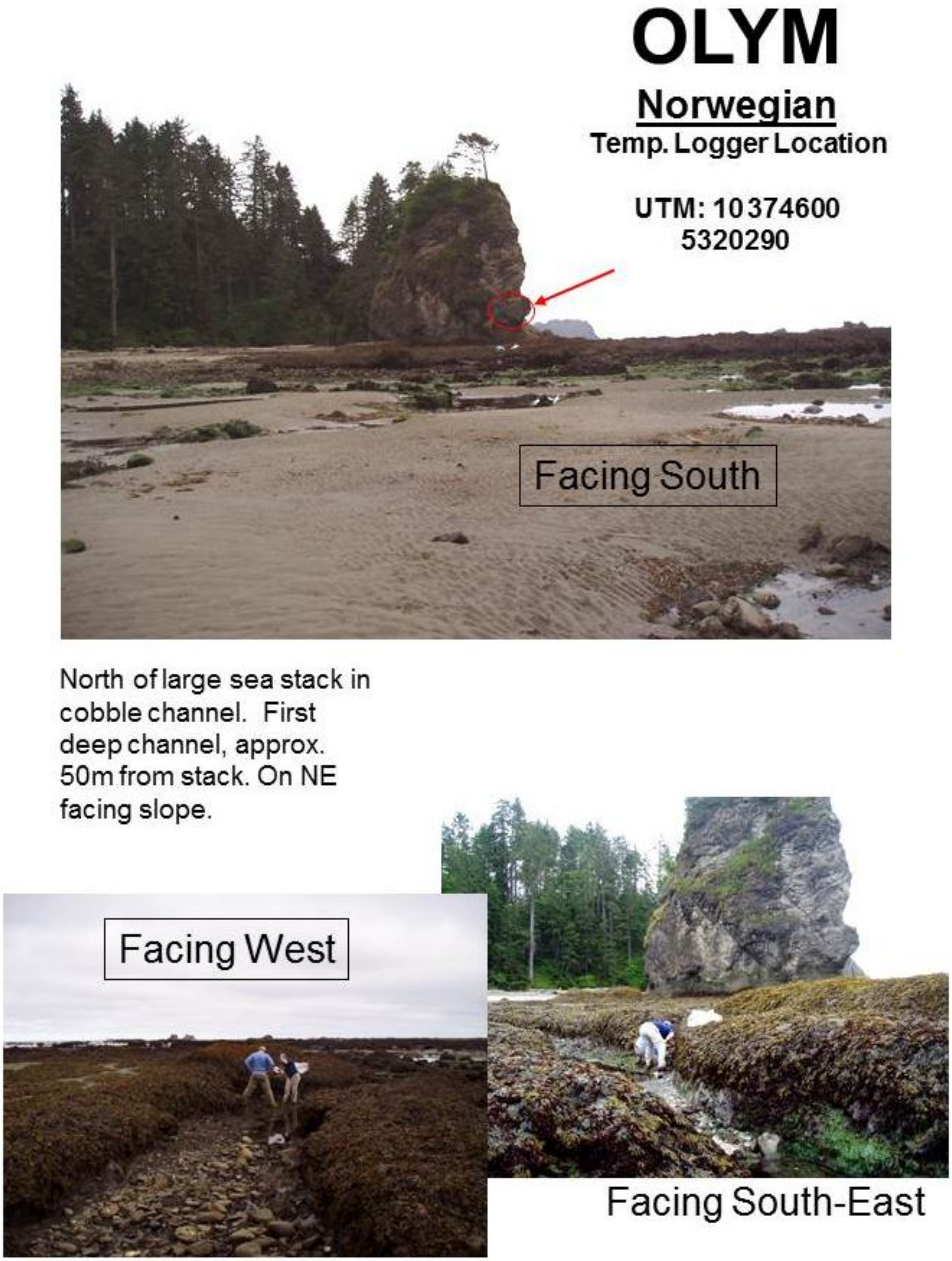


Figure S5.6. Location of the temperature datalogger at Norwegian Memorial, OLYM.

Figure S5.7. Location of the temperature datalogger at Point of the Arches, OLYM.

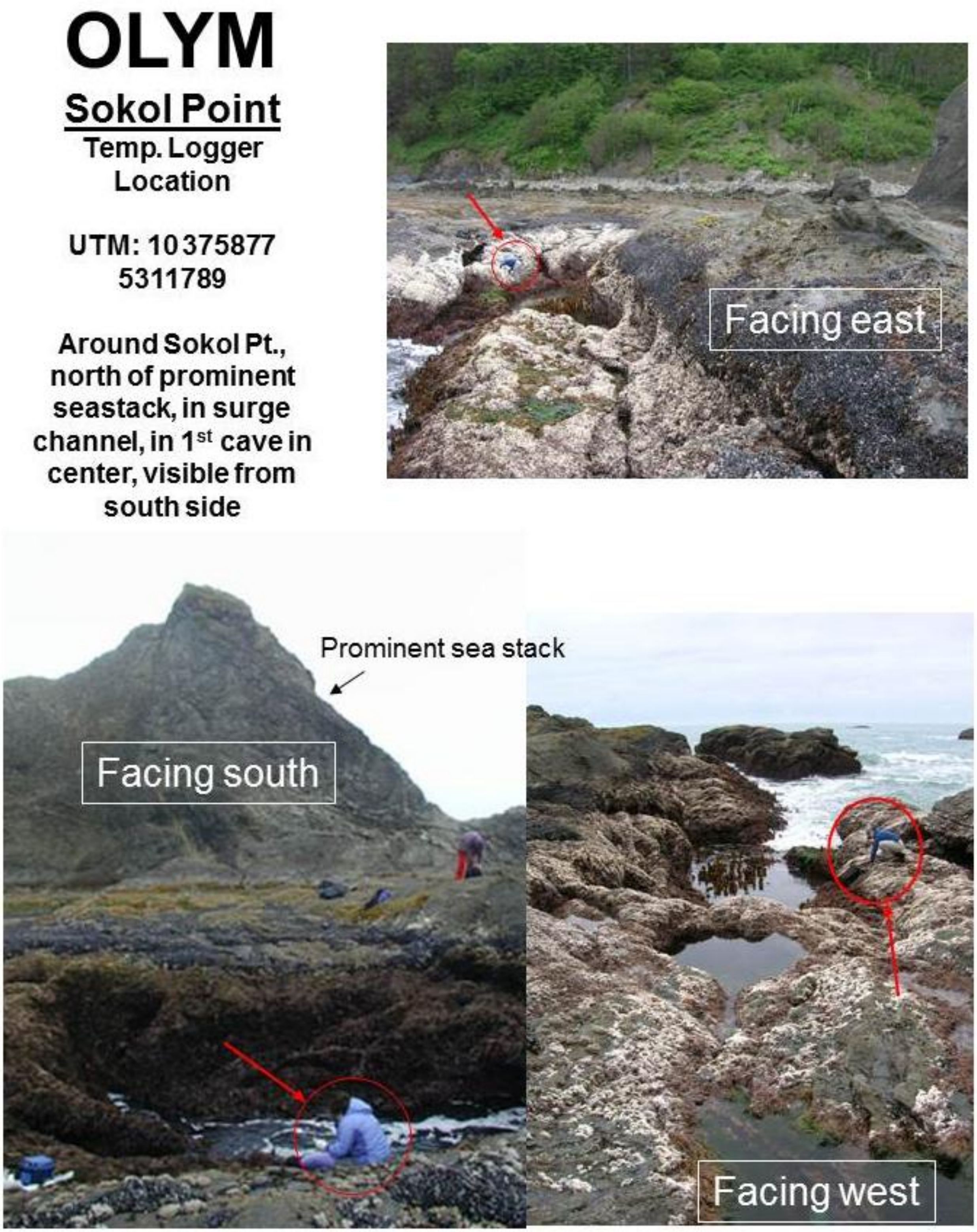


Figure S5.8. Location of the temperature datalogger at Sokol Point, OLYM.

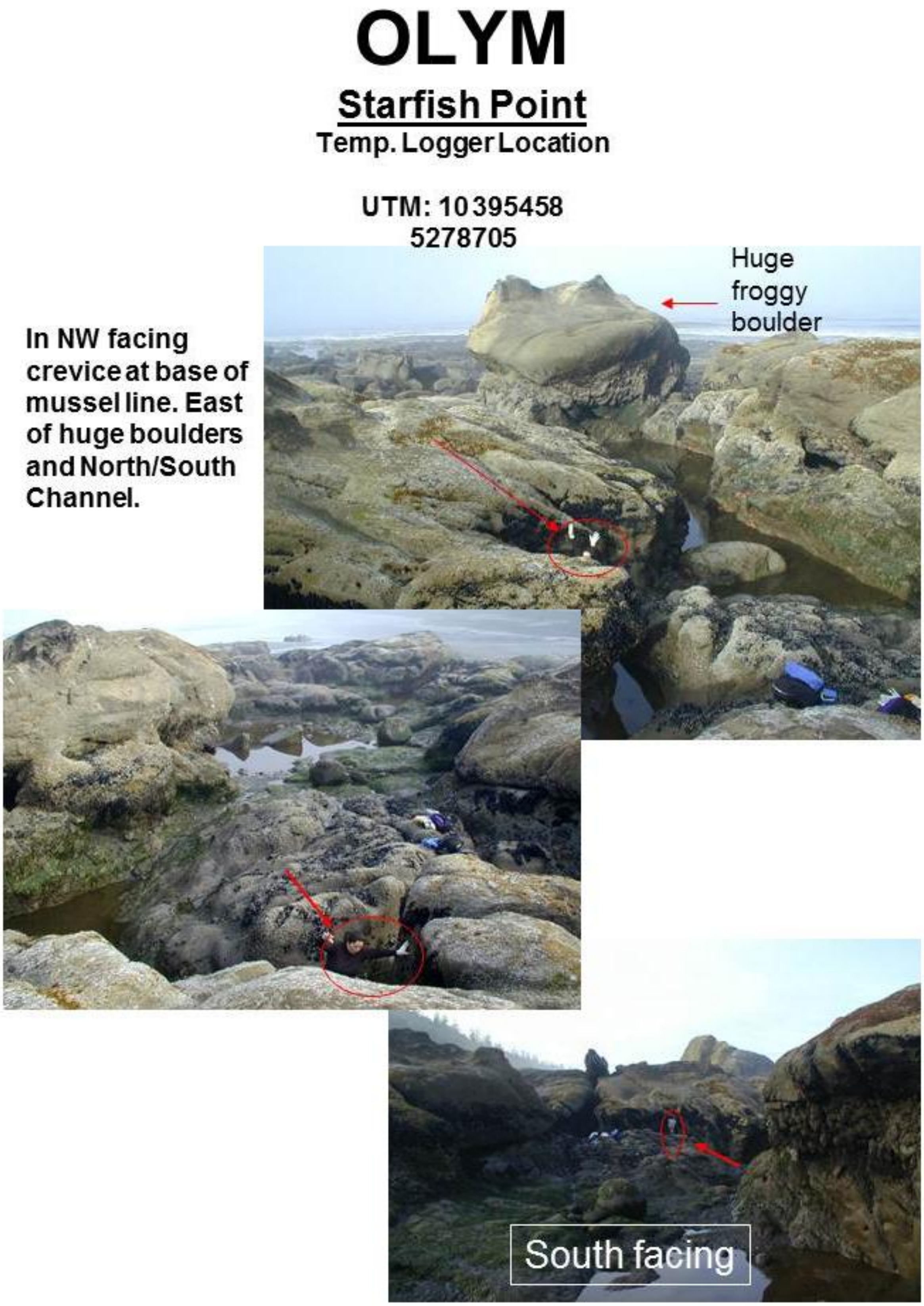


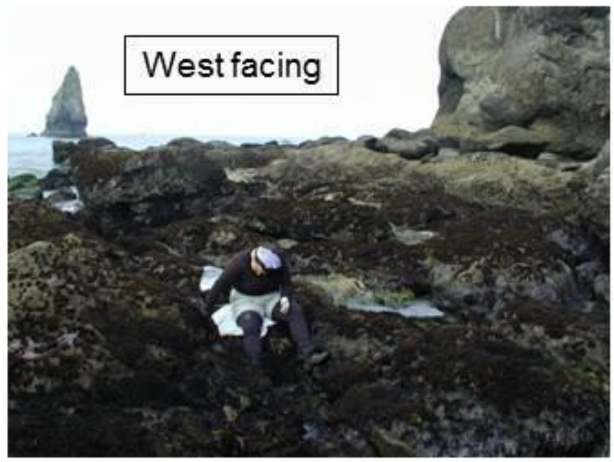
Figure S5.9. Location of the temperature datalogger at Starfish Point, OLYM.

OLYM

Taylor Point

Temp. Logger Location

UTM: 10 382705 E
5302610 N



Logger located on NE slope of long rock crevice close to water. Directly between “mini overland” trailhead & western cone shaped sea stack off shore. Approx. 20 m south of Taylor Bluff, NE of “cave”.

Figure S5.10. Location of the temperature datalogger at Taylor Point, OLYM.

Figure S5.11. Location of the temperature datalogger at Ecola State Park (Oregon), LEWI.

Figure S5.12. Location of the temperature datalogger in the American Camp unit of SAJH.

Figure S5.13. Location of the temperature datalogger in the English Camp unit of SAJH.

SOP 6: Project Workspace and Records Management

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Mar 2009	J. Boetsch	---	Original
Jan 2012	J. Boetsch	Clarifications and updates	Peer-review revisions and updates to current standards

Overview

This SOP describes how and where project files and records are managed by project staff. Workspace structure, naming conventions, and procedures for handling project files are included.

NCCN File Workspace

NCCN has a centralized file system and project workspaces available for use by field crews and project staff at: \\inpolymfs\parkwide\NCCN. This will help avoid the problem of NCCN projects having several versions of files on different servers around the network. These folders are set up so that park and network staff members at the network parks all have read privileges throughout the directory structure. Project leads and a few other individuals associated with each project have full privileges for their project folder so they can manage their own permissions. These workspaces are intended to be a more familiar and convenient way of storing information, as an adjunct to the NCCN SharePoint site. Apart from reports and protocols – which are to be maintained in the NCCN Digital Library (a section of the NCCN SharePoint site) – project leads will decide what is to be stored locally in these project workspaces as opposed to on the team SharePoint site. Examples of files kept in these project workspaces include: working files for project field crews, GPS downloads, GIS map files, database files, and other project records.

The NCCN file workspace is organized as follows under four main folders: Libraries, Projects, Temp, and Workspace. Project staff members will primarily be working in one or more of the project folders under Projects, and may wish to make desktop shortcuts to one or more of the project subfolders by right-clicking on the desired folder and selecting Send To > Desktop (create shortcut).

Project staff members should create a network shortcut to the project workspace by going to the Desktop in Windows Explorer and adding a new network place under My Network Places. Project staff located at OLYM will typically already have this path available to them via a mapped drive (e.g., the I:\ drive); however, they should still create this network shortcut where multiple parks are concerned for the sake of communications and consistency among parks. Performance is the main rationale for using network shortcuts instead of mapped drives at other parks.

Instructions for creating a network shortcut to the NCCN workspace:

1. Open an instance of Windows Explorer. One way is from the Start menu, go to: All Programs > Accessories > Windows Explorer. Another is to open My Documents, My Computer, or any other folder browser shortcut.
2. Navigate to the Desktop, and then to My Network Places.
3. Double-click the Add Network Place option to open the setup wizard.
4. Choose the option to specify the network location, then under network address, type in: \\inpolymfs\parkwide\NCCN
5. When prompted for a name for the network place, enter "NCCN" (or something similarly brief and meaningful).
6. This network place shortcut should now be available each time you log in to that particular computer, and can be accessed when navigating within most Windows software.

Project Workspace

A section of the NCCN workspace is reserved for this project. The recommended file structure within this workspace is shown in Figure S6.1.

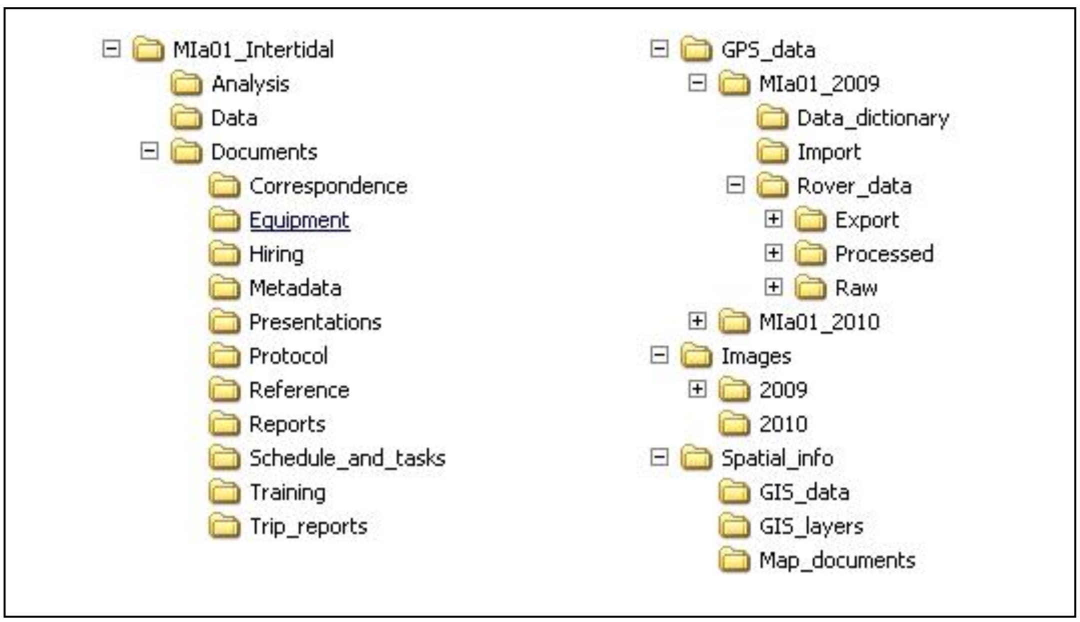


Figure S6.1. Recommended file structure for project workspace. Note: The workspace folder name includes 'MIa01', the NCCN project code.

Each major subfolder is described as follows:

- Analysis – Contains working files associated with data analysis.

- Data – Contains the front-end database application file for the season. The back-end database for the project is maintained in Microsoft SQL Server. Database exports and other intermediate summary information can be stored here as well; these files are most effectively managed within subfolders named by calendar year.

- Documents – Contains subfolders to categorize documents as needed for various stages of project implementation. Additional folders and subfolders may be created as needed to arrange information in a way that is useful to project staff.

- GPS data – Contains GPS data dictionaries, and raw and processed GPS data files. This folder contains subfolders to arrange files by year. Each of these subfolders also contains the project code to make it easier to select the correct project folder within the GPS processing software.

- Images – For storing images associated with the project. This folder has subfolders named by calendar year to make it easier to identify and move files to the project archives at the end of each season. Refer to **SOP 8: Managing Photographic Images** for more details.

- Spatial info – Contains files related to visualizing and interacting with GIS data.
    - GIS data – New working shapefiles and coverages specific to the project.
    - GIS layers – Pointer files to centralized GIS base themes and coverages.
    - Map documents – Map composition files (.mxd).

Seasonal Workspace

In addition to these permanent folders, a temporary seasonal workspace is established at the beginning of each field season (e.g., "2012_field_crew"). This temporary workspace provides a place for field crew members to create and modify files while limiting access privileges for the remainder of the project workspace. Subfolders are created for Images and GPS data to allow field crew members to process incoming files as needed. Temporary workspaces may also be established on other servers to provide local access to crews stationed at other parks. At the end of the season, files in these temporary workspaces are then filed in the appropriate permanent folder(s).

Folder Naming Standards

In all cases, folder names should follow these guidelines:
- No spaces or special characters in the folder name.
- Use the underbar (“_”) character to separate words in folder names.
- Try to limit folder names to 20 characters or fewer.
- Dates should be formatted as YYYYMMDD (this leads to better sorting than other date naming conventions).

File Naming Standards

Unless otherwise specified, file names should follow these guidelines:
- No spaces or special characters in the file name.

- Use the underbar ("_") character to separate file name components.
- Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters.
- Dates should be formatted as YYYYMMDD.
- Correspondence files should be named as YYYYMMDD_AuthorName_subject.ext.

Workspace Maintenance Procedures

Prior to each season, the Project Lead should:

1. Make sure that network accounts are established for each new staff member, or reactivated for returning staff members. By default, the IT staff puts new user accounts into a group that has read-only access to all files.
2. Create new folders named by year under the Images and GPS data sections.
3. Create the seasonal workspace, with subfolders for Images and GPS data.
4. Add user logins for the seasonal crew members to the seasonal workspace, with modify privileges. This can be done by right-clicking on the seasonal workspace folder, selecting Properties > Security, then adding users one at a time and checking the box in the Allow column for Modify privileges.
5. Provide the Data Manager with a list of user logins that need modify access to the seasonal workspace and databases.

After each season, the Project Lead should:

1. Review the workspace organization and clean up any temporary files and subfolders that are no longer needed.
2. Move files from the seasonal workspace folders into the appropriate permanent folder(s), and archive or delete the seasonal workspace folders as desired. See **SOP 8: Managing Photographic Images** for specific instructions for images.
3. Compare older files against the retention schedule in NPS Director's Order 19 (available at: http://home.nps.gov/applications/npspolicy/DOrders.cfm). Dispose of files that are beyond their retention schedule if they are no longer needed. As a long-term project, many files associated with this project are likely to be scheduled for permanent retention. This makes it all the more imperative to clean out unneeded files before they accumulate and make it harder to distinguish the truly useful and meaningful ones.
4. Convert older files to current standard formats as needed to maintain their usefulness.
5. Identify files that may contain sensitive information (as defined in Section 4J of the narrative). Such files should be named and filed in a way that will allow quick and clear identification as sensitive by others.
6. Post final documents and files to the NCCN Digital Library for long-term storage. See **SOP 10: Product Delivery, Posting and Distribution**.
7. Send analog (non-digital) materials to the park collections for archiving.

SOP 7: Managing Photographic Images

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Mar 2009	J. Boetsch	---	Original
Jan 2012	J. Boetsch	Changes to post-season cleanup procedure	Update and Clarification

Overview

This SOP describes procedures for downloading, processing and naming photographic images collected by project staff or volunteers during the course of conducting project-related activities. Images that are acquired by other means – e.g., downloaded from a website or those taken by a cooperating researcher – are not project records and should be stored separately and named in such a way that they can be readily identified as non-NPS images and not be mistaken for project records.

To effectively manage potentially hundreds of images requires a consistent method for downloading, naming, editing and documenting. The general process for managing project images is as follows:

1) Prepare image workspace – set up the file organization for images prior to acquisition.
2) Acquire images.
3) Download and process.
    a) Download the files from the camera
    b) Rename the image files according to convention
    c) Copy and store the original, unedited versions
    d) Review and edit or delete the photos
    e) Move into appropriate folders for storage
4) Deliver image files for final storage.

Data Photos Defined

Care should be taken to distinguish data photographs from incidental or opportunistic photographs taken by project staff. Data photographs are those taken for the following reasons:

- To document a particular feature or perspective for the purpose of site relocation
- To capture site characteristics and possibly to document gross structural changes over time
- To document a species detection that is also recorded in the data

Data photographs are often linked to specific records within the database, and are stored in a manner that permits the preservation of those database links. Other photographs – e.g., of field crew members at work, or photographs showing the morphology or behavior of certain intertidal species – may also be retained but are not necessarily linked with database records.

Image Workspace Setup

Prior to each season, the Project Lead (or a designee) should create a new set of image folders under the new season year under the Images section of the project workspace and seasonal workspaces (refer to **SOP 6: Project Workspace and Records Management**). The workspace subfolders are as follows:

[Year]	The appropriate year – 2009, 2010, etc.
[Park code]	Arrange files by park – OLYM, LEWI, etc.
1_Originals	Unedited versions of image files
[Download date]	Arranged by download date to preserve file names
2_Processing	Temporary processing workspace
[Site_code]	Arranged by site, for images taken at a site
[Capture date]	Arranged by date, for images not taken at a site
3_Data	Data images
[Site_code]	Arranged in subfolders by site
4_Miscellaneous	Non-data images taken by project staff
[Site_code]	Arranged by site, for images taken at a site
[Capture date]	Arranged by date, for images not taken at a site
5_Not_NPS	Images acquired from other sources

This folder structure permits data images to be stored and managed separately from non-record and miscellaneous images collected during the course of the project. This structure also provides separate space for image processing and storage of originals. For additional information about the project workspace, refer to **SOP 6: Project Workspace and Records Management**.

In all cases, folder names should follow these guidelines:

- No spaces or special characters in the folder name.
- Use the underbar ("_") character to separate words in folder names.
- Try to limit folder names to 20 characters or fewer.
- Date names should be formatted as YYYYMMDD.

Image Acquisition Standards

Capture images at an appropriate resolution that balances space limitations with the intended use of the images. Although photographs taken to facilitate future navigation to the site do not need to be stored at the same resolution as those that may be used to indicate gross environmental change at the site, it may be more efficient to capture all images at the same resolution initially. A recommended minimum raw resolution is 1600 x 1200 pixels (approximately 2 megapixels). Higher resolutions may be available but are undesirable from the perspective of data storage and information content.

Download and Processing Procedures

1. Under the appropriate "Originals" subfolder, create a subfolder for the download date (e.g., 20090715). Other suffixes may be used to distinguish downloads when multiple sites or parks are downloaded on the same date.
2. Download the raw, unedited images from the camera into the new subfolder. Depending on the operating system used by the person downloading, it may be possible to greatly reduce the time and effort it takes to rename the images in subsequent steps.
   - Plug in the camera to the USB port and turn the camera on.
   - From the Start menu, select All Programs > Accessories > Scanner and Camera Wizard (or select this option if a dialog box appears upon plugging in the camera).
   - Follow screen prompts until reaching the 'Picture Name and Destination' screen. You will be able to select name prefix/suffix, image format, and photo destination.
     - For name prefix, use the naming conventions indicated later in this SOP.
     - For image file format, select the default (JPG).
     - For photo destination, browse to the appropriate "Originals" subfolder.
3. Copy the images to the “Processing” folder and set the contents under "Originals" as read-only by right clicking in Windows Explorer and checking the appropriate box. These originals serve as backups in case of unintended file alterations (e.g., incorrect names applied, file deletion, loss of resolution, or loss of image metadata upon rotation).
4. Finish renaming the images in the "Processing" folder according to convention (refer to the image naming standards section).
   - If image file names were noted on the field data forms, be sure to update these to reflect the new image file name prior to data entry. Field form annotations should be done in a different color ink from the original notation, after first drawing a line through the original entry (for more information, refer to **Section 4D, Data Entry and Processing**).
   - Renaming may be most efficiently done as a batch using image processing software such as Microsoft Office Picture Manager, which allows a standard prefix or suffix to be added to the camera file name. After batch renaming, a descriptive component may be added manually to each file name.
5. Process the images in the "Processing" folder, using the edit features built into image software programs such as ThumbsPlus or Microsoft Office Picture Manager. At a minimum, the following processing steps should be performed on all image files:
   - Delete photographs of poor quality – e.g., out of focus, light levels, etc. Low quality photographs might be retained if the subject is highly unique, or the photo is an irreplaceable data photo.
   - Duplicates should also be deleted unless they provide unique information. Other non-data photographs should be evaluated against their potential long-term value.
   - Rotate images to make the horizon level.
   - Remove 'red eye' glare in photographs of people.
   - Crop non-data images to remove edge areas that grossly distract from the subject.
6. Optional processing steps may include enhancing contrast or brightness, or resizing images to make them small enough for use in documents or on the web. These steps are not recommended for data photos.

7. When finished processing the current download, move the image files that are to be retained to the appropriate folder – i.e., data images to the appropriate "Data" subfolder, other images under the appropriate "Miscellaneous" folder.
8. Photos of potential interest to a greater audience should be uploaded to the NCCN Digital Library.
9. Delete files from the "Processing" folder between downloads to minimize the chance for accidental deletion or overwriting of needed files.

Image File Naming Standards

In all cases, image names should follow these guidelines:

- No spaces or special characters in the file name.
- Use the underbar (“_”) character to separate file name components.
- Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters.
- Park code and year should either be included in the file name (preferred), or specified by parent folders in the directory structure.
- Dates should be formatted as YYYYMMDD (this leads to better sorting than other date naming conventions).

The image file name should consist of the following parts:

1. The date on which the image was taken (formatted as YYYYMMDD)
2. 4-character park code, if not taken at a site
3. Site location abbreviation:
    a. SAJH
        i. ENG = English Camp
        ii. AMC = American Camp South
    b. OLYM
        i. POA = Point of Arches
        ii. SOK = Sokol Point
        iii. TAY = Taylor Point
        iv. SFP = Starfish Point
        v. SHI = Shi Shi Beach
        vi. SPS = Sand Point
        vii. CCS = Cedar Creek
        viii. 2BS = Second Beach
        ix. TPS = Toleak Point
        x. SBS = Steamboat Creek
        xi. KBS = Kalaloch Beach
        xii. CBT = Cannonball Island temperature
        xiii. NMT = Norwegian Memorial temperature
        xiv. GCT = Goodman Creek temperature
        xv. BPT = Brown's Point temperature
    c. LEWI
        i. SUN = Sunset Beach
        ii. ECO = Ecola State Park
4. Target species, for MARINe target photo plots and seastar plots:

   a. BARN = MARINe barnacle photo plots
   b. MUSS = MARINe mussel photo plots
   c. STAR = MARINe seastar plots
5. Optional: a brief descriptive word or phrase
6. Optional: a sequential number if multiple images were captured
7. Optional: time (formatted as HHMM)

Examples:

• 20100612_SOK_BARN_1_1425.jpg	MARINe barnacle photo point #1 taken at Sokol Point at 14:25 on June 12, 2010
• 20090621_SFP_com_overview_001.jpg	Photo image #1 of an overview of the community rock site "Starfish Point" taken on June 21, 2009
• 20090518_OLYM_sand_training_004.jpg	4th photo taken during sand monitoring training at OLYM on May 18, 2009

Post-season Cleanup Procedures

At the end of the season, field crew members should organize images within the seasonal workspace and notify the Project Lead, after making sure that all processing folders are empty.

After each season, the Project Lead (or a designee) should:

1. Review the seasonal workspace folders to make sure that all images are properly named and filed and accounted for.
2. The "Processing" folder should be empty and may be deleted.
3. Files in the "Not_NPS" folder may be re-filed as appropriate.
4. The contents of the "Originals" folder may be deleted once all desired files are accounted for. Originals of data images may be retained as desired, depending on the size of the files and storage limitations. If storage space is limiting, originals may be stored on a local hard drive or external drive.
5. Copy the entire contents of the "Images" subfolder from the seasonal workspace to the main project workspace, and delete the images subfolders from the seasonal workspace.
6. Set the images in the project workspace to read-only to prevent unintended changes.

SOP 8: Data Entry, Quality Assurance, Review and Certification

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Mar 2009	S.C. Fradkin	---	Original
Jan 2010	S.C. Fradkin	Minor clarifications	Peer-review revisions

Introduction

Ensuring that high quality data are collected, analyzed and archived is of vital importance to the NPS I&M Program. This SOP describes additional procedures for quality assurance and quality control (QA/QC) for the NCCN Intertidal Monitoring Protocol. Many other important aspects of QA/QC for this protocol are discussed in the protocol narrative and also in descriptions of specific SOPs.

Target Population, Representativeness and Completeness

The target populations for this protocol are the sand beach infauna and rocky platform organisms along the coastline of OLYM, LEWI and SAJH. Specifically, the target populations are the communities in the higher elevation zones of these habitats. Lower elevation communities and other habitat types (i.e. mixed-coarse sediment beaches) are not represented in this protocol for logistical reasons described in the protocol narrative, **Chapter 2: Sampling Design**. While both sand beach and Community rocky platform monitoring provide statistical inference to the entire population of such habitats in these parks, this inference is most robust for the sand beach monitoring because it has adequate replication. From a population-wide perspective, the rocky platform monitoring provides a representative approach. A complete robust inferential rocky design would require increased site replication, which is not logistical or fiscally feasible at this time.

The target population for OLYM has seven sand beaches, four MARINe rocky platform monitoring sites, four Community rocky platform monitoring sites, and eight Intertidal temperature monitoring sites. LEWI will have one MARINe rocky platform monitoring site (Ecola State park), one sand beach monitoring site, and two intertidal temperature monitoring sites. SAJH will have two MARINe rocky platform monitoring sites and four intertidal monitoring sites.

Data Comparability

Once this protocol passes peer review and is accepted for implementation, changes or alterations to sampling procedures and methods will be kept to a minimum to assure comparability of data over the long term (i.e. >30 yrs). If new sampling procedures are implemented, these will be phased in for a concurrent period with the old sampling procedures so that conversions or correlations between data from the two procedures can be determined.

Methods used for the MARINe Rocky Platform monitoring are consistent with those used by a host of west coast monitoring organizations, including several NPS units, under the umbrella of the MARINe monitoring network. Inclusion of this monitoring component will ensure comparability of data across a regional and west coast scale.

Measurement Quality Objectives

The measurement quality objectives for the Hobo-Tidbit temperature data loggers appear in Table S8.1 below.

Table S8.1. Measurement quality objectives for temperature data loggers.

Parameter	Instrument	Measurement Systematic Error	Method Detection Limit (MDL)	Practical Range of Determination
Temperature	Hobo Tid-bit v2	± 0.2 º C	0.02 º C	-5 to 70 º C

Data Entry and Verification

The following are general guidelines for data entry and verification in the project database application:

1. All field data are reviewed for completeness and accuracy twice, once before departure from the field site, and a second time upon arrival back at the laboratory and before filing of datasheets into the project file cabinet. After the second review, the data reviewer will initial and date each data sheet in the appropriate section.
2. Data should be entered as soon after data collection as possible so that field crews remain current with data entry tasks, and identify any errors or problems as close to the time of data collection as possible. Typically data entry will occur in between low tide series during the field season.
3. As data are being entered, the person entering the data should visually review each data form to make sure that the data on screen match the field forms. This should either be done for each record prior to moving to the next form for data entry, or preferably as a separate step after all of the data for a sampling trip has been entered. Important: It is a requirement that all events must be entered and verified at the end of the field season.
4. The front-end database application is a Microsoft Access file maintained in the project workspace (see **SOP 6: Project Workspace and Records Management**). This front-end copy may be considered “disposable” because it does not contain any data, but rather acts as an interface with data residing in the back-end database. It contains the forms, queries, and formatted report objects for interacting with the data in the back-end.
5. The back-end database for this project is implemented in Microsoft SQL Server to take advantage of the automated backup and transaction logging capabilities of this enterprise database software.

6. Each data entry form is patterned after the layout of the field form, and has built-in quality assurance components such as pick lists and validation rules to test for missing data or illogical combinations. Although the database permits users to view the raw data tables and other database objects, users are strongly encouraged only to use the pre-built forms as a way of ensuring the maximum level of quality assurance.

At regular intervals and at the end of the field season the Crew Lead should inspect the data that have been entered to check for completeness and perhaps identify avoidable errors. The Crew Lead may also periodically run the Quality Assurance Tools that are built into the front-end application to check for logical inconsistencies and data outliers.

Database Instructions

Getting Started

The first action to be taken is to make sure the project workspace is set up properly on a networked drive. Refer to **SOP 6: Project Workspace and Records Management** for instructions on how to set up and access the project workspace.

Important Reminders for Daily Database Use

1. If accessing the database from a remote park (i.e., other than OLYM Headquarters), do not open and use the front-end application outside the remote desktop environment as it will run very slowly and likely stall. Instead, refer to the following instructions on remote access before using the application.
2. If accessing the database from OLYM, do not open and use the front-end application on the network as this makes it run more slowly. Instead, copy the front-end file from the project workspace to your local desktop and open it there. This copy can be replaced with new versions as they are released.
3. New versions of the front-end application may be released as needed through the course of the field season. When this happens, you may see a notification about a new release when opening the current or older versions of the front-end. Copies of the outdated version of the front-end file should be deleted and replaced with the new version, which will be named in a manner reflecting the update (e.g., Intertidal_2012_v2.mdb).
4. Upon opening the front-end application for the first time, there may be a need to reconnect the front-end to the back-end, depending on how the project workspace is mapped on your computer. This database connection update should only need to be done once for each new release of the front-end database.

Remote Connections for Data Entry and Database Access

Most of our project databases are hosted on a server at OLYM Headquarters. Due to bandwidth limitations, project database users accessing these databases from other parks (or from remote locations at OLYM Headquarters) may encounter slow performance or application errors when accessing the database directly via a networked drive or a local front-end file. Therefore, to make data entry as smooth and efficient as possible, such users will typically need to use a remote desktop connection each time they need to access the database.

Remote desktop connections access what is called a "terminal server" at OLYM. In doing so, all of the processing is occurring on a server collocated with the database server, thus minimizing the negative effects of bandwidth on application performance. Through such a connection, the remote user is essentially sending mouse moves and keystrokes to the terminal server, and receiving screen updates in return. There may be some noticeable lag time in mouse moves and screen updates, but the performance is often much better than when accessing the data through other means.

Instructions for Using Remote Desktop

1. From the Start menu, go to: All Programs > Accessories > Communications > Remote Desktop Connection. You may wish to create a desktop shortcut by right clicking on the Remote Desktop Connection icon in the menu and selecting Send To > Desktop.
2. With the Remote Desktop window open, type in the terminal server name: "inpolymts1".

3. Click on the Connect button.
4. Enter your NPS login and password. Note that the login must be preceded by "NPS\", for example: "NPS\gwashington".
5. The remote desktop session will open and you will see a blank desktop that represents what you would see if you were sitting at the computer at OLYM. The first time you use it you may need to map network drives you use frequently and create other useful shortcuts (e.g., to the project workspace), and you will need to use the Access 2010 first-time setup instructions (see the following section) so that the project database functions properly. These initial setup steps should only need to be done once, however.
6. You may switch back and forth between your remote session and your local session (i.e., on your local workstation) using the connection bar across the top of the remote desktop screen.
7. When using the project database, you may need to make a copy of the front-end application if someone else is already using the file (evidenced by a ".ldb" lock file with the same name and in the same folder as the front-end file). You may also want to create your own subfolder in the project workspace for your own front-end copy to avoid these conflicts with other users.
8. When you are finished with your remote session, log off by clicking on Start > Log Off.

The first time you use Remote Desktop, you may wish to select Options from the first Remote Desktop Connection screen to enter more specific information for your frequent remote desktop sessions (e.g., enter "inpolymts1" for the computer, your NPS login, and "NPS" for the domain so you don't have to enter "NPS\" in front of your login each time). Do NOT enter your password or check the box to save your password, as this may present a security risk.

Special Instructions for Access 2010

If you are going to be using Access 2010, make sure the security settings will allow the database to function properly. This is necessary because Access 2010 may have been installed in a very restrictive security mode that disables the functionality built into the project database. Note: This setting change should only need to be performed once. However, if you move to a different workstation, these steps may need to be repeated to allow the database to perform properly. You will know the difference if none of the buttons or form functions on the main database switchboard form work properly, or if you get the following warning message across the top of the window:

To enable the database content to run properly on a consistent basis, do the following:

1. Prior to using the front-end database, open Access 2010 from the Start menu.
2. Go to Start > All Programs > Microsoft Office > Microsoft Office Access 2010.
3. In the upper left corner, click on the Office Button.
4. At the bottom of the menu page, click the Access Options button.
5. Select the Trust Center category on the left panel.
6. In the lower right, click the Trust Center Settings button.
7. Select the Macro Settings category on the left panel.
8. Select the option “Enable all macros”. Then hit OK, and exit Access.
9. From this point forward the project database application should function properly on that computer.

User Roles and Privileges

The database application provides different levels of access privileges: read-only, data entry, power user, and administrator. These privileges are assigned based on user login by the Project Lead or a designee at the beginning of each field season. Most field crew users will be granted "data entry" rights, which allow one to enter and edit data for the current field season only. Certified data and lookup domains may only be edited by users with power user or administrator privileges. If a user name is not granted explicit rights to the database, the application will open in "read-only" mode.

Overview of Database Components

The front-end application has multiple functional components, which are accessed from the main application switchboard form that opens automatically when the application starts. Several buttons are found on the form to provide access to different components of the application, and are arranged in functional categories:

- Data Entry and Edits

  - Enter / edit data – Opens a form to confirm default settings (e.g., park, coordinate datum) prior to continuing to the project-specific data entry screens.
  - Task list – Keeps track of unfinished tasks associated with sample locations (for example, forgotten equipment, unfinished data collection) that one field crew can use to communicate with a future field crew.

- Database Admin
  - Db connections – Manage and update the connections to the back-end database(s).
  - Set user roles – Manage the list of users who may view, enter and edit the database. Provides four levels of access: read-only, data entry, power user, and admin. This button is only enabled for power users and administrators.
  - View db objects – Allows the user to view and edit database objects (tables, queries and forms). This button is only enabled for power users and administrators.

- Management Tools
  - Data browser – Opens a tabbed form that provides comprehensive access to data arranged by sampling location. This form has headers for filtering by park, location code, location type and status.
  - Lookup tables – Opens a tool for managing the lookup values for the project data set (e.g., species list, list of project personnel).
  - Sampling schedule – Opens a form to view and edit the sampling schedule.
  - QA checks – Opens the data validation and quality review tool, which shows the results of pre-built queries that check for data integrity, missing data, and illogical values, and allows the user to fix these problems and document the fixes.
  - Edit log – Opens a form for documenting edits to certified data records.

- Summaries and Output
  - Data summaries – Opens a form for viewing and exporting summary queries for data exploration, analysis and reporting.
  - Task list report – Generates a report of tasks that need to be accomplished for a specified park or sample location (default is for all locations).
  - Navigation report – Generates the field season Navigation Report used to relocate sample locations and brief the crew on tasks that need to be accomplished.
  - Quality review report – Generates the data quality review results for a selected year or all years.

Verifying Data Records

Field crews must verify all sampling events throughout the field season. The recommended approach is for one crew member to do all of the data entry for one sample location, then have another crew member review and verify records for that location. The current record status for each sampling event is shown in the Data Gateway Form. To see all of the sampling events in the database, be sure to turn off the filters to show all of the sampling points and events. By double-clicking on the record status field in the Data Gateway Form, the appropriate data entry form will be opened for verification.

To complete the verification step: After all data for a given sampling event have been entered completely, the database entries should be compared against the original field forms. Each of the main data entry screens – e.g., Rocky Intertidal, Sand Data, MARINe Target Species – has a footer containing fields for storing quality assurance information about the event, and information on who created the sampling event record, who last updated it, etc. When all data for the sampling location have been verified, click on the button that says "Verify this sampling event" to indicate that the event record is complete and accurately reflects the field forms. Clicking this button instantly updates the record status in the Data Gateway for that sampling event. Remember that subplot data will need to be verified before clicking the "Verify" button on the main Event Log form.

Data Quality Review

A critical part of project quality assurance is the year-end data quality review and certification. After the season's field data have been entered and processed, they need to be reviewed and certified by the Project Lead before they can be used for analysis and reporting. Data validation is the process of rigorously testing data for completeness, structural integrity, and logical consistency. Although the front-end data entry forms have built-in quality assurance measures – such as domain lookup pick lists, defined range limits for numeric data, and checks for missing values – not all errors can be caught during the data entry step. The following are a few of the general sources of data problems that might be identified during the validation:

1. The response design is ambiguous or insufficiently documented to prevent data gaps and logical inconsistencies.
2. There were logistics problems or a change of plans that prevented a complete sample (e.g., weather conditions, staffing changes).
3. Field crew members did not collect or properly record one or more data elements in the field.
4. Data were entered incorrectly or incompletely.
5. Database records were edited incorrectly or deleted after entry.
6. There is a design flaw in the front-end application that causes data errors during or after data entry.

Given the varied sources of data problems, there is a need for a thorough check of data quality on a regular basis as a means of ensuring continued data quality throughout the span of the project. The front-end database application includes a Quality Review Tool to facilitate the review process by showing the results of pre-built queries that check for data integrity, data outliers, missing values, and illogical values. The user may then fix these problems and document the fixes. Not all errors and inconsistencies can be fixed (e.g., missing response variable values), in which case documentation of the resulting errors and why records were not fixed is included in the metadata and certification report.

Once the data have been through the validation process and metadata have been developed for them, the Project Lead should certify the data by completing the NCCN Project Data Certification Form, available on the NCCN website.

Validation Queries

Table 13.1 shows the set of validation checks that are performed on the data set. Each line represents a pre-built database query that checks for potential problems in the data set, including data outliers, missing values, and illogical values. The set of queries is customized to match project requirements and the structure of the underlying data model. Each query is classified in one of three categories:

1. Critical – These queries check for structural integrity problems or gaps in critical information. This category might include queries that check for missing primary key values, mismatches between data values and lookup domain values, duplicate records, or illogical data combinations. Records returned by these queries fail to meet basic project requirements or structural requirements of the data model, and must be fixed so that they do not return any records before the data can be certified.
2. Warning – These queries represent problems that range in importance, but in any case have the potential to compromise data usability or representativeness if they are not addressed or at least made known to the end user. This category might include queries that check for missing response variables (e.g., tallies of individuals observed) or values that are beyond a reasonable range; alternatively, it may include queries that require follow-up on data records that can only be done after the field season (e.g., changing status of a monitoring location from "Proposed" to "Active"). The person performing the quality review should make efforts to fix as many of these records as possible by reviewing hard-copy data forms or otherwise following up. However, it may frequently be the case that records in this category cannot be fixed because the reviewer does not have the information needed to fix the record. In such cases the reviewer should provide documentation about which records were not fixed and why using the space provided in the quality review tool (see below). If there are numerous records that cannot be fixed, a general description such as "80 records" or "all pellet survey sites, 65 records", along with a statement of why these were not fixed, will suffice. Documentation will help future data users to know that reasonable efforts were made to address the problems.
3. Information – These queries provide information that can be used to evaluate the completeness and logical consistency of the data set – for example, the number of plots visited per park in a given season, the range of dates for sampling visits, or the number of pellet groups recorded during a sampling event. This category may also include checks for missing values in less-vital or optional fields, where a large number of missing values may be anticipated on a regular basis (i.e., as an alternative to making these Warning queries that require follow-through and documentation).

The queries are named and numbered hierarchically so that high-order information – for example, from tables on the parent side of a parent-child relationship such as sample locations – is addressed before low-order information (e.g., individual pellet group observation records). The rationale for this is that one change in a high-order table affects many downstream records, and so proceeding in this fashion is the most efficient way to isolate and treat errors.

The set of queries may need to be augmented or changed as project requirements shift. The Data Manager is also available to revise queries or construct new database queries as needed. Throughout the quality review, the person performing the review should remain vigilant for problems that may not be caught by the validation queries. One task that cannot be automated is the process of making sure that all of the data for the current season are in fact entered into the database. This will often involve manual comparisons between field forms or other lists of the sites visited against the results of queries showing the sites for which data exist.

Using the Quality Review Tool

Open the front-end database application and hit the button labeled “QA checks” to open the quality review form. Upon opening, the quality review form automatically runs the validation queries and stores the results in a back-end database table (tbl_QA_Results). Each time the query results are refreshed, the number of records returned and the run times are updated so that the most recent result set is always available. Reviewer name and remedy descriptions are retained between query runs. Together, these results form the basis of documentation in the certification report output as shown below.

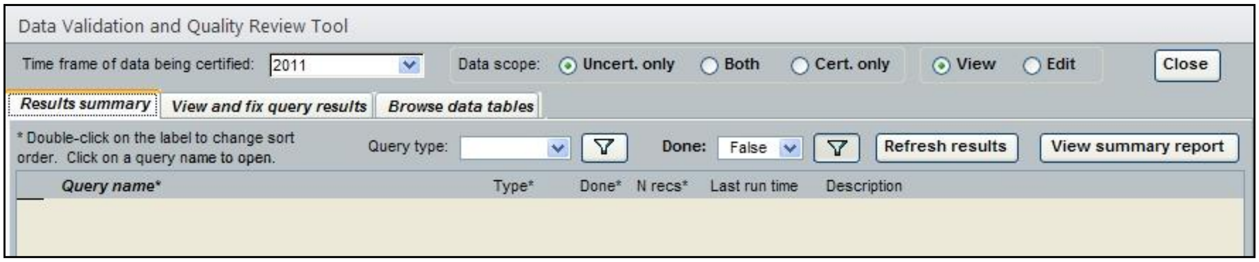
Across the very top of the form are indicators of the time frame (i.e., sample year) and scope of the data being validated. Data scope has three options:

- Uncertified data only (default) – Only uncertified events (i.e., those from the current sampling year) will be considered in validation queries. Note that by design, certain queries will evaluate for problems in records are associated with certified data anyway – for example, all location records are evaluated for duplicate location codes, even those associated only with certified sampling events.
- Both uncertified and certified data – All database records will be included, including certified event data from previous years.
- Certified data only – Only certified events from previous seasons will be considered in the validation queries.

Changing the data scope will show only results for that scope – in other words, results and fixes associated with one scope will be retained even if the scope is changed and the results are refreshed.

The first tab of the quality review form contains a results summary showing each validation query, the type of query (i.e., Critical, Warning or Information), the number of records returned by the query, the most recent query run time, and the description. At the top of the page, there is a button for refreshing the full set of results, which may need to be done periodically as changes in one part of the data structure may change the number of records returned by other queries. Records default to sort by query name, but can be sorted by double-clicking on any of the column headings indicated with an asterisk.

There is also a "Done" checkbox that the reviewer can use as an indicator that they are finished looking at that particular query. Critical and Warning queries that return zero records from the start are automatically set to "Done". The results records may be filtered by query type and/or by whether or not the query has been marked as "Done". Note that updating records in one query may change the number of records returned by another query; if the number of records returned by a query changes, the "Done" indicator will be switched off automatically.



Upon double-clicking a particular query name, the second page will open up to show the results from that query. The "Query description" field will indicate the kind of records returned, and may also include a suggested remedy.

In the upper-right is a switch that allows the user to put the form in either view mode (default) or edit mode. Upon changing to edit mode, the form changes color to provide a visual reminder that edits are possible. At this point the query results may be modified and any documentation may be entered in the "Remedy details" section. If certain records in a query result set are not to be fixed for whatever reason, this is also the place to document that. Reviewer name is automatically filled in (if it was blank) once the user updates the documentation. If the reviewer does not have sufficient information to fix one or more records returned by a query, s/he should describe which records were not fixed and why. If there are numerous records that cannot be fixed, a general description such as "80 records" or "All pellet plots, 43 records", along with a statement of why these were not fixed, will suffice. Documentation will help future data users to know that reasonable efforts were made to address the problems.

Some of the other functions of this second page of the Quality Review Tool:

- Edit results directly? – A flag to indicate whether the results for the selected query can be edited directly inside the query results subform. Queries that contain complex joins, subqueries, or grouping functions cannot be edited directly, and instead must be edited in the original data entry form.
- Auto-fix – A button that runs an action query for bulk updates if such a solution is appropriate and available (e.g., replacing all missing values with a code for "Unknown"). Not all validation queries contain references to a bulk update query.

- Open selected record – Opens the selected record returned by the query in the appropriate form. This is useful for quickly moving to the place where the fix can be made most efficiently, and taking advantage of existing quality assurance functionality.
- Data browser – Opens the Data Browser form, which provides comprehensive access to data arranged by sampling location.
- Export to Excel – Exports the validation query results to Excel. This can be helpful when there is a need to follow up on complex problems or to verify that all data have been entered.
- Requery – Reruns the validation query and updates the results set.

On this page is also a button labeled “Design view”, which will open the currently selected query in the design interface in Access. In this manner, the user can verify that the query is in fact filtering records appropriately. Note: Please contact the Data Manager before making any changes to query structure or names.

Finally, the third page of the Quality Review Tool is for viewing and editing data tables directly if needed. This page is only available for those with power user or administrator privileges to the database. Important: As with all edits performed during the quality review, these types of direct edits in the data tables should be made with extreme care as many of the quality assurance measures built into the data entry forms are not present in the tables themselves. It is possible, therefore, to make edits to the tables that may result in a loss of data integrity and quality.

Completing Data Certification

Data certification is a benchmark in the project information management process that indicates that: 1) the data are complete for the period of record; 2) they have undergone and passed the quality assurance checks outlined above; and 3) they are appropriately documented and in a condition for archiving, posting and distribution as appropriate. Certification is not intended to imply that the data are completely free of errors or inconsistencies that may or may not have been detected during quality assurance reviews.

To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. The Project Lead is the primary person responsible for completing an NCCN Project Data Certification Form, available at: http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm. This brief form should be submitted with the certified data according to the timeline in **Appendix 1: Yearly Project Task List**. Refer to **SOP 10: Product Delivery, Posting and Distribution** for delivery instructions.

Generating Output for the Certification Report

The first page of the Quality Review Tool has a button labeled “View summary report”. This button opens the formatted information for each query, the last run time, the number of records returned at last run time, a description and any remedy details that were typed in by the user. This report can be exported from the database and included as an attachment to the certification report

SOP 9: Data Analysis

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Jan 2009	S.C. Fradkin	---	Original
Jan 2010	S.C. Fradkin	Minor clarifications	Peer-review revisions

Introduction

This SOP discusses the approach that will be used in data handling, summary analyses and trend analyses in the intertidal data collected for this protocol. Issues associated with the statistical analysis of intertidal time series have been considered in the ecological literature (Murray et al. 2006). While some have argued the utility of distribution-based parametric analyses, a growing literature exists recommending the use of non-parametric multivariate analyses (Clarke 1993). This protocol will employ both parametric analyses and non-parametric multivariate analyses for long-term trend analyses associate with the various monitoring components. Analyses used to examine monitoring data will include exploratory analyses to summarize and visualize data, and analyses for trend detection. At less frequent intervals (i.e., 5-10 yrs) external environmental data (e.g., wave height/disturbance, upwelling indices, surface chlorophyll) will be extracted from existing public databases (e.g., NOAA National Data Buoy Center, NOAA SeaWiFS Coastwatch Program) to examine the relationship between and observed biological trends and trends in physical environmental variables. A summary of the standard analyses to be employed for each monitoring component is found in Table S9.1.

Table S9.1. Summary of the type of analyses to be conducted for each monitoring component.

		Monitoring Component			
Analysis Type		**Temperature**	**Sand**	**MARINe Rock**	**Community Rock**
Exploratory	**Descriptive**	✓	✓	✓	✓
	Graphical	✓	✓	✓	✓
Trend	**Regression**	✓	✓	✓	✓
	REMANOVA	✓	✓	✓	✓
	ANCOVA			✓	
	Multivariate		✓	✓	✓

Exploratory Data Analyses

Exploratory data analyses will be used to summarize data for the annual report (see **Appendix 1: Yearly Project Task List** for the reporting schedule). Exploratory analyses for parameters will consist of computations of descriptive statistics and graphical analyses.

Descriptive Statistics

- *Measures of central tendency*: These measures are useful for assessing the average or center value of a group of samples. Standard measures to be calculated include: mean, median. Examples include: mean daily maximum and minimum water and air temperature, mean species abundance in monitoring plots, etc.
- *Measures of dispersion*: These measures provide insight into the variability of observations around the center of the distribution. For trend detection the power to detect trends decreases with increases in variability. Standard measures of dispersion to be calculated include: standard deviation, standard error, variance, coefficient of variation, 95% confidence intervals.

Graphical Analyses

Bivariate plots: These graphical displays are useful for visually assessing the relationship of a parameter (individual value or mean) over time (see Figure S9.1 for examples). Bivariate plots will be constructed for raw and refined intertidal temperature data, in addition to the mean abundance of key species in rock and sand monitoring plots.

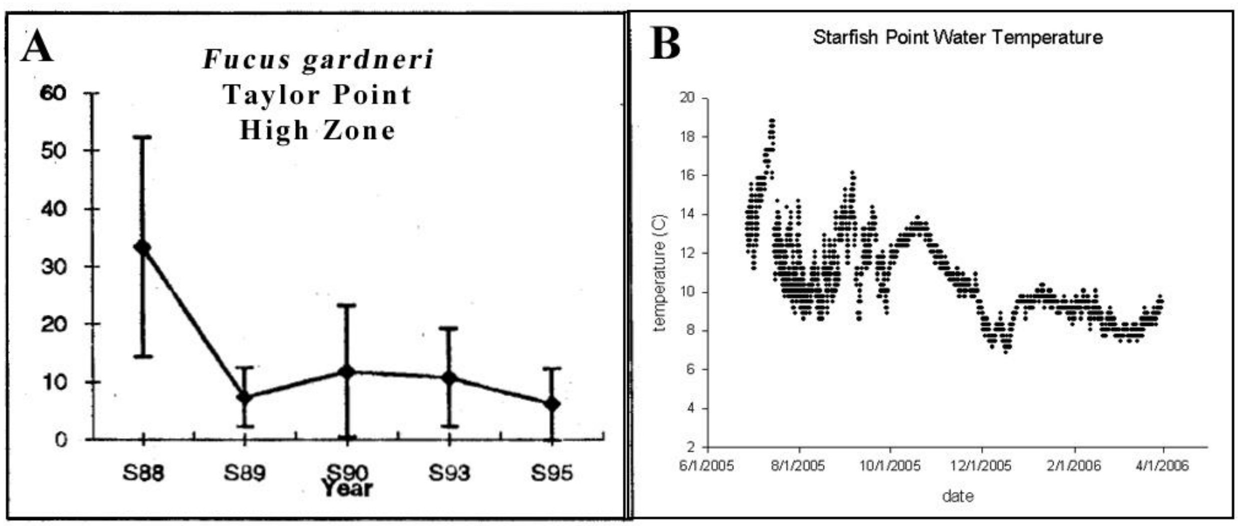


Figure S9.1. Example bivariate plot illustrating intertidal patterns over time. A) A plot of the mean percent cover (± SD) of the alga F. gardneri in the high intertidal zone at Taylor Point OLYM. Data are historical monitoring data derived from a different plot design than proposed here (figure modified from Dethier 1995). B) An annual temperature data series from Starfish Point OLYM, derived from a temperature datalogger. These raw data represent both water and exposed surface temperatures.

Trend Analyses

Regression Analyses

Trends in water temperature, species abundance, and percent cover at rocky shoreline and sand beach sites will be estimated using least square regression techniques (Neter et al. 1996, Nielson and McDonald 2005). Examples from historical OLYM intertidal data are in Figure S9.2. Least squares methods are unbiased and have minimum variance among all unbiased linear estimators, and are often favored over maximum likelihood estimators (MLE) for normal linear regression when sample sizes are small (Neter et al. 1996). Annual densities, percent covers, and species richness for each zone/site will be *ln(x)* transformed to correct for inconstant residual variance and will be fit to the simple linear regression model:

$$y_t = \alpha + \beta t + e, \qquad [1]$$

where y_t is the response at time *t* (year of monitoring program), α is a constant (intercept), β is the slope, or estimate of trend, and *e* was random error. SAS Proc GLM (SAS Institute 2000) will be used to fit model [1] to the data. The coefficient of determination R^2 will be calculated to assess the overall model fit, where an R^2 value near 1.0 indicates a high correlation between abundance/percent cover and year, while a value near 0.0 indicates a low correlation and a poor overall model fit. Statistically significant trends will be identified at the $\alpha = 0.10$ level.

Repeated Measures ANOVA analyses

The assumptions of regression analyses can be violated if autocorrelation exists between data points from the same site sampled over time. In these instances where error terms are not independently distributed, regression analysis is not appropriate and repeated measures ANOVA analyses. In the 5-year review analysis, once enough time series data has been accumulated to analyze, tests of autocorrelation will be performed and if found, repeated measures ANOVA analyses will be conducted, in lieu of regression analyses, to identify trends.

Coastwide MARINe Analyses

NCCN MARINe Target Species data will be annually exported to the master MARINe database housed at the University of California, Santa Barbara (see Chapter 4, Section K). Analyses of coastwide data in the broader MARINe program, including NPS and non-NPS units, will be conducted at irregular intervals in coordination with MARINe partners. These analyses to assess temporal patterns of abundance and percent cover for target species within and between sites will use Analysis of Covariance (ANCOVA) as conducted in Miner et al. (2005).

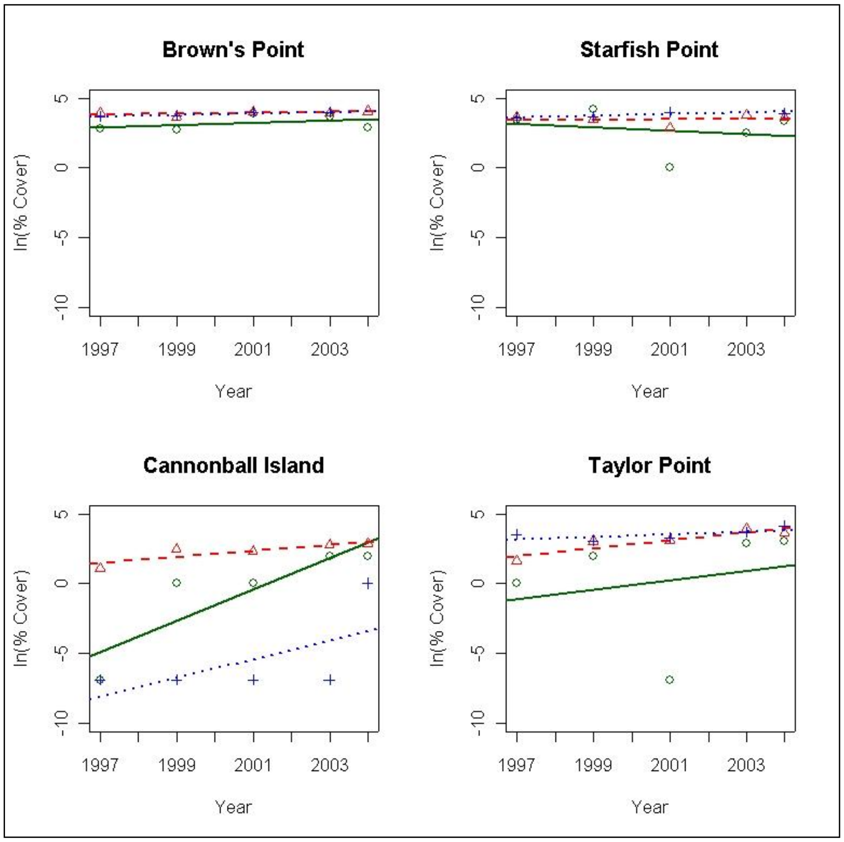


Figure S9.2. Trends in ln(% cover) of the barnacle *Balanus glandula* at 4 rocky sites. Solid green lines and “o” = mid transects, dashed red lines and triangles = High transects, and dotted blue lines and ‘+’ = Very High transects (from Nielson and McDonald 2005).

Multivariate Analyses of Community Structure

Changes in the community structure of zones and sites in the rocky shoreline and sand beach monitoring components will be analyzed following the methods of Clarke (1993) and Anderson (2001) (Figure S9.3) using Primer v6 and PERMANOVA+ software (Clarke and Gorley 2006, Anderson 2008). Species abundance and percent cover data for replicates will be combined into single values (*sensu* Dufrene and Legendre 1997) and transformed to correct for high and low values (i.e. log (x+1), 4^{th} root). From these data, Bray-Curtis similarity matrices will be generated. Non-metric Multi-Dimensional Scaling (NMDS) analyses will be performed on matrices to create 2-dimensional visualizations of similarity patterns in community structure. Taxa contributing most to community similarity will be identified using Similarity Percentage Analyses (SIMPER). A distance-based permutational multivariate analysis of variance (PERMANOVA) will be used to determine temporal trends (Denitto et al. 2007, Pranovi et al. 2007) (Figure S9.4). Differences in community structure between sites and years will be examined using Analysis of Similarity (ANOSIM) tests.

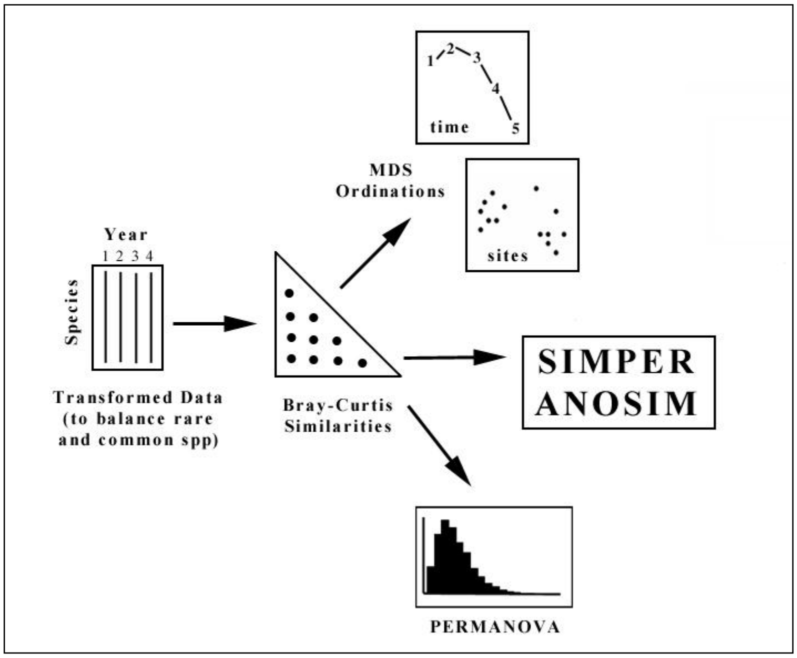


Figure S9.3. Schematic diagram illustrating the stages in developing multivariate community analyses of rock and sand intertidal communities using Primer 6 software. Data are converted into similarity matrices that are subsequently analyzed for trend and taxa contributing most to similarity (PERMANOVA, SIMPER, ANOSIM). Community patterns over time and between sites are visualized via NMDS analysis.

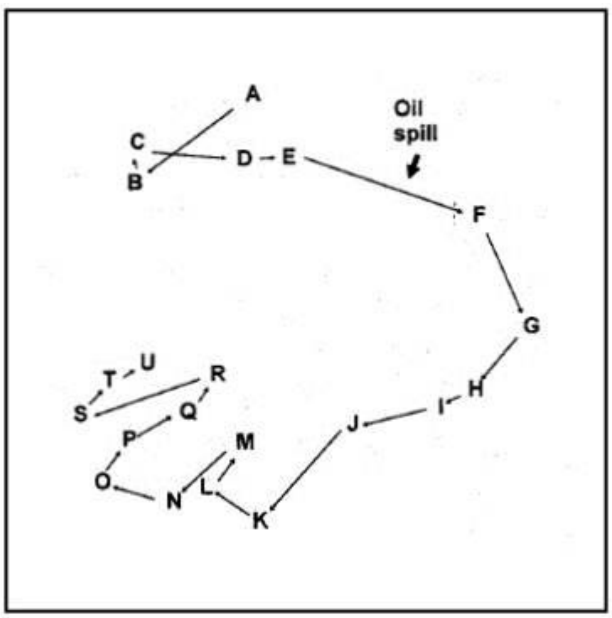


Figure S9.4. An example of an NMDS plot illustrating a temporal trend in macrobenthic community structure at station “Pierre Noire” before and after the oil from the Amoco-Cadiz in the Bay of Morlaix, France. The time series progression is from times A to U representing quarterly sampling over a 5 year period (modified from Clark and Warrick 2001).

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SOP 10: Product Delivery, Posting and Distribution

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Mar 2009	J. Boetsch	---	Original

Overview

This SOP provides a schedule, product specifications, and instructions for delivering completed data sets, reports and other project deliverables for long-term storage. Details are also provided on posting products to websites and clearinghouses, and on responding to data requests.

Product Delivery Schedule and Specifications

Table S10.1. Schedule and instructions for project deliverables.

Deliverable Product	Primary Responsibility	Target Date	Delivery Instructions
Field season report	Field Lead	September 30 of the same year	Upload digital file in Microsoft Word format to the NCCN Digital Library.
Digital photographs	Project Lead	November 30 of the same year	Organize, name and maintain photographic images in the project workspace according to **SOP 7: Managing Photographic Images**.
Certified back-end database	Project Lead	November 30 of the same year; data are not posted to public sites until June of the second year	Refer to the section in this SOP on delivering certified data and related materials.
Certified geospatial data	Project Lead with GIS Specialist		
Data certification report	Project Lead		
Metadata interview form	Project Lead		
Full metadata (parsed XML)	Data Manager and GIS Specialist	March 15 of the following year	Upload the parsed XML record to the NPS Data Store [1].
Annual I&M report	Project Lead	May 1 of the following year	Refer to the section in this SOP on reports and publications.
5-year analysis report	Project Lead and Data Analyst	Every 5 years by May	
Other publications	Project Lead and Data Analyst	as completed	
Field data forms	Project Lead	Jan 31 of the following year	Scan original, marked-up field forms as PDF files, and store in the project workspace. Hard copy originals go to the Park Curator for archiving.

Table S10.1. Schedule and instructions for project deliverables (continued).

Deliverable Product	Primary Responsibility	Target Date	Delivery Instructions
Voucher specimens	Project Lead and Field Lead	Jan 31 of the following year	Label, package and send to Park Curator for archiving. See the section in this SOP on Park Collections.
Other records	Project Lead	review for retention every January	Retain or dispose of records following NPS Director's Order 19 [2]. Organize and send analog files to Park Curator for archiving. Digital files that are slated for permanent retention should be uploaded to the NCCN Digital Library.

[1] NPS Data Store is an internet clearinghouse for documents, data and metadata on natural and cultural resources in parks. It is a primary component of the NPS Integrated Resource Management Applications (IRMA) portal (http://irma.nps.gov).

[2] NPS Director's Order 19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: http://home.nps.gov/applications/npspolicy/DOrders.cfm.

NCCN Digital Library

The NCCN Digital Library is a document management system maintained in a Microsoft SharePoint environment at: http://imnetsharepoint/nccn/default.aspx. The primary purpose of this system is to maintain important digital files – such as reports, protocol documents, and select project images – within a content management system, and to make them available to NCCN and NPS users. NCCN users may view, post and edit documents within this system; other NPS users have read-only access to these files, except where information sensitivity may preclude general access.

To enable discovery and long-term usability of key documents, certain information about each file needs to be filled in as files are uploaded, for example:

- Document title
- Project code (e.g., "MIa01" for Intertidal Monitoring)
- Park(s) to which the file(s) apply; multiple parks may be selected for each upload
- Document type (e.g., formal report, database, protocol, etc.)
- Date of publication or last revision
- Author name(s)
- Sensitivity: Sensitive, NPS Only, or Public. Sensitive files will not be viewable without permission. For a definition of sensitive information, see **Chapter 4J, Identifying and Handling Sensitive Information**.
- Description - Document abstract, additional authors and credits, special use instructions, etc.

For project staff without access to the NPS intranet, files may be sent by email or CD/DVD to the Project Lead or Data Manager for upload, along with the above information in a text file or accompanying email.

Park Collections

The collections at OLYM will serve as the park of record for the Intertidal Monitoring Project. Voucher specimens, hardcopy field forms, and printouts of annual reports, technical reports, and other publications will be filed there. In addition, other hard copy project records should be reviewed and organized on an annual basis (or at the conclusion of a project), and sent to park collections for long-term storage.

The Project Lead should contact the Park Curator during the project planning if voucher specimens will be collected. All specimens must be labeled with NPS accession and catalog numbers, and with advance notice the Park Curator can help to provide these numbers ahead of time so they can be included in label printouts. Specimen label information will be entered by the Park Curator into the ANCS+ database. The Park Curator will help to decide which and how many specimens can be maintained at the park versus sent to another institution or collection. Collected materials remain NPS property even if they later reside in a non-NPS collection (e.g., university herbarium).

Delivering Certified Data and Related Materials

Data certification is a benchmark in the project information management process that indicates that the data: 1) are complete for the period of record; 2) have undergone and passed the quality assurance checks; and 3) are appropriately documented and in a condition for archiving, posting and distribution as appropriate. To ensure that only quality data are included in reports and other project deliverables, the data certification step is an annual requirement for all tabular and spatial data. For more information refer to **SOP 8: Data Entry, Quality Assurance, Review and Certification**.

The following deliverables should be delivered as a package:

- *Certified back-end database* – Database containing data for the current season that has been through the quality assurance checks documented in **SOP 8: Data Entry, Quality Assurance, Review and Certification**. Delivery of this item is only applicable in cases where the back-end database is implemented in Microsoft Access and/or is deployed outside the NPS firewall during the quality review. In all other cases, the Data Manager will already have access to the certified data.
- *Certified geospatial data* – GIS themes in ESRI coverage or shapefile format. Refer to NCCN GIS Development Guidelines (NCCN 2007a) and NCCN GIS Product Specifications (NCCN 2007b) for more information.
- *Data certification report* – A brief questionnaire in Microsoft Word that describes the certified data product(s) being delivered. A template form is available on the NCCN website at: http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm.

- *Metadata interview form* – The metadata interview form is a Microsoft Word questionnaire that greatly facilitates metadata creation. It is available on the NCCN website at: http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm. For more information, refer to **Chapter 4F, Metadata Procedures**.

After the quality review is completed, the Project Lead should package the certification materials for delivery as follows:

1. Create a compression file (using WinZip® or similar software, or by right-clicking in Windows Explorer). This file should be named in accordance with general file naming standards, and the name should include the project code ("MIa01") and the year or span of years for the data being certified. For example: MIa01_2012_certification_pkg.zip.
2. In cases where the back-end database is implemented in Microsoft Access and/or is deployed outside the NPS firewall during the quality review:
    a. Open the certified back-end database file and compact it (in Microsoft Access version 2003 and earlier, Tools > Database Utilities > Compact and Repair Database). This will make the file size much smaller. Back-end files are typically indicated with the letters "_be" in the name (e.g., Intertidal_MIa01_be_2012.mdb).
    b. Add the back-end database file to the compression file.
    c. Note: The front-end application does not contain project data and as such should not be included in the delivery file.
3. Add the completed metadata interview and data certification forms to the compressed file. Both files should be named in a manner consistent with the file naming standards described in **SOP 6: Project Workspace and Records Management**.
4. Add any geospatial data files that aren't already in the possession of the GIS Specialist. Geospatial data files should be developed and named according to NCCN GIS Naming Conventions (NCCN 2007c).
5. Deliver the compressed file containing all certification materials to the Data Manager by placing it in the Data folder of the project workspace and notifying the Data Manager by email. If the Project Lead does not have network access, then certification materials should be delivered as follows:
    a. If the compressed file is under 9.5 mb in size, it may be delivered directly to the Data Manager by email.
    b. If the compressed file is larger than 9.5 mb, it should be copied to a CD or DVD and delivered in this manner. Under no circumstances should products containing sensitive information be posted to an FTP site or other unsecured web portal (refer to **Chapter 4J, Identifying and Handling Sensitive Information**).

Upon receiving the certification materials, the Data Manager will:

1. Review them for completeness and work with the Project Lead if there are any questions.
2. Check in the delivered products using the NCCN project tracking application.
3. Notify the GIS Specialist if any geospatial data are delivered. The GIS Specialist will then review the data, and update any project GIS data sets and metadata accordingly, and file those products in the project workspace.

4. Work with the GIS Specialist to finalize coordinate data in the database, generate public coordinates (as applicable – see **Chapter 4J, Identifying and Handling Sensitive Information**), and update any GIS-derived data fields therein (e.g., elevation, slope, aspect).
5. Archive the certified products in the project workspace.
6. Notify the Project Lead that the year's data have been successfully reviewed and processed. The Project Lead may then proceed with data summarization, analysis and reporting.
7. Develop, parse and post the XML metadata record to the NPS Data Store.
8. After a holding period of 2 years, the Data Manager will upload the certified data to the NPS Data Store. This holding period is to protect professional authorship priority and to provide sufficient time to catch any undetected data quality problems.

No sensitive information (e.g., information about the specific nature or location of protected resources) may be posted to the NPS Data Store or any other publicly-accessible website, or otherwise shared or distributed outside NPS without a confidentiality agreement between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. Only products that are intended for public/general-use may be posted to public websites and clearinghouses – these may not contain sensitive information.

Instructions for Reports and Publications

Annual reports and trend analysis reports will use the NPS Natural Resource Publications template, a pre-formatted Microsoft Word template document based on current NPS formatting standards. Annual reports will use the Natural Resource Technical Report (NRTR) template, and trend analysis and other peer-reviewed technical reports will use the Natural Resource Report (NRR) template. These templates and documentation of the NPS publication standards are available at: http://www.nature.nps.gov/publications/NRPM/index.cfm.

The procedures for annual reports, technical reports, and publications are as follows. (Note: This is optional for field season reports, which are intended to be internal communications only.)

1. The Project Lead or Data Analyst formats the document according to the NPS Natural Resource Publications standards.
   a. Formatting according to NPS standards is easiest when using the report template from the very beginning, as opposed to reformatting an existing document.
   b. When creating the file, use appropriate naming standards (described in this document). If creating the document in SharePoint (e.g., the NCCN Digital Library), attribute the file as a draft; otherwise add "DRAFT" to the file name.
   c. Open the document and add "DRAFT" to the header or document watermark as appropriate.
2. The document should be peer reviewed at the appropriate level. For example, I&M Annual Reports should be reviewed by other members of the project work group. The Network Program Manager will also review all annual reports for completeness and compliance with I&M standards and expectations. Before sending the document for

review, rename the document by adding a date stamp to the end of the file name using the YYYYMMDD format.

3. Upon completing the peer review, the Project Lead should acquire a publication series number from the appropriate regional or national key official. Instructions for acquiring a series number are available at: http://www.nature.nps.gov/publications/NRPM/index.cfm.
4. The Project Lead should finalize the document:
    a. Ensure that the publication/version date (last saved date field code in the document header, if used) and file name (field code in the document footer, if used) are updated properly throughout the document.
    b. Remove the word "DRAFT" from watermarks, document headers, and file name.
    c. Remove any previous date stamp from the file name.
    d. If the document has been developed and maintained in SharePoint (e.g., the NCCN Digital Library), update the document attribute to "Final".
    e. To avoid unplanned edits to the document, reset the document to read-only by right-clicking on the document in Windows Explorer and checking the appropriate box in the Properties popup.
    f. Create a PDF version of the document and upload the final file and PDF copy to the NCCN Digital Library for long-term storage.
    g. Store both the Word document and PDF copy in the appropriate section of the project workspace (see **SOP 6: Project Workspace and Records Management**).
5. Notify the Park Curator and Data Manager that the report is available, and send a printout to the Park Curator to add to the host park collections.
6. The Data Manager (or a designee) will create a bibliographic record and upload the PDF copy to the NPS Data Store according to document sensitivity.

File Naming Standards

Prior to delivering or uploading digital products, files should be named according to the naming conventions appropriate to each product type.

<u>Reports and Publications</u>

- No spaces or special characters in the file name.
- Use the underbar ("_") character to separate file name components.
- Try to limit file names to 30 characters or fewer, up to a maximum of 50 characters.
- Dates should be formatted as YYYYMMDD.
- As appropriate, include the project code (e.g., "MIa01"), network code ("NCCN") or park code, and year in the file name.

Examples:

- NCCN_MIa01_2012_Annual_report.pdf
- NCCN_MIa01_2012_Field_season_report.doc
- NCCN_MIa01_2012_Certification_report.doc

Other Files

General naming standards as described in **SOP 6: Project Workspace and Records Management** apply to all deliverables. When delivering files to the NCCN Digital Library, file names should be modified as needed to include the project code (e.g., “MIa01”), network code (“NCCN”) or park code, and year as appropriate (e.g., NCCN_MIa01_2012_cert_package.zip). Specific standards for images are described in **SOP 7: Managing Photographic Images** and in **SOP 11: Revising the Protocol** for protocol documents.

Product Posting

Once digital products have been delivered and processed, the Data Manager or a designee will post them to or otherwise update the following applications to make them generally available:

1. The NPS Data Store is an internet clearinghouse for documents, data and metadata on natural and cultural resources in parks. It is a primary component of the NPS Integrated Resource Management Applications (IRMA) portal (http://irma.nps.gov). Refer to the section on sensitive information in **Section 4J, Identifying and Handling Sensitive Information** for information on options for flagging products containing sensitive information within the system, or for modifying products prior to posting so that they no longer contain sensitive information and can therefore be shared broadly. Full metadata records will be posted to the NPS Data Store as they are created; data sets will be posted after a two-year hold to protect professional authorship priority and to provide sufficient time to catch any undetected quality assurance problems. For reports and other publications, an online record is created after first verifying that one does not already exist. The digital report file in PDF format is then uploaded.

2. NPSpecies is the NPS database and application for maintaining park-specific species lists and observation data, and is also a component of the IRMA portal (http://irma.nps.gov). Species observations will be extracted from project data sets and uploaded into NPSpecies.

3. NCCN Web Site is maintained by NCCN staff as part of the NPS Inventory and Monitoring web site (http://science.nature.nps.gov/im/units/nccn) to describe our program, the vital signs selected for monitoring, and to highlight certain products and information derived from inventory and monitoring work at NCCN. The site has both internet and intranet components. Select products such as annual reports and technical reports will be posted to the web site.

These applications serve as the primary mechanisms for sharing reports, data, and other project deliverables with other agencies, organizations, and the general public.

Holding Period for Project Data

To protect professional authorship priority and to provide sufficient time to complete quality assurance measures, there is a two-year holding period before posting or otherwise distributing certified project data. This means that certified data sets are first posted to publicly-accessible websites (i.e., the NPS Data Store) approximately 24 months after they are collected (e.g., data collected in June 2010 and certified in February 2011 becomes generally available through the NPS Data Store in February 2013). In certain circumstances, and at the discretion of the Project Lead, data may be shared before a full two years have elapsed.

Note: This hold only applies to raw data, and not to metadata, reports or other products which are posted to NPS clearinghouses immediately after being received and processed.

Responding to Data Requests

Occasionally, a park or project staff member may be contacted directly regarding a specific data request from another agency, organization, scientist, or from a member of the general public. The following points should be considered when responding to data requests:

- For all Inventory and Monitoring projects in NCCN, NPS is the originator and steward of the data, and the NPS Inventory and Monitoring Program should be acknowledged in any professional publication using the data.
- NPS retains distribution rights; copies of the data should not be redistributed by anyone but NPS.
- The data that project staff members and cooperators collect using public funds are public records and as such cannot be considered personal or professional intellectual property.
- No sensitive information (e.g., information about the specific nature or location of protected resources) may be posted to the NPS Data Store or another publicly-accessible website, or otherwise shared or distributed outside NPS without a confidentiality agreement between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. Refer to **Chapter 4J, Identifying and Handling Sensitive Information**.
- For quality assurance, only certified, finalized versions of data sets should be shared with others. In exceptional cases where a provisional data set needs to be shared with others prior to certification:
    - Any accompanying communications should clearly indicate that the data set is provisional and subject to change according to our quality review process.
    - File names and the media it is sent on should be clearly labeled as containing provisional data not for distribution.

The Project Lead will handle all data requests as follows:

1. Discuss the request with other Park Biologists as necessary to make those with a need to know aware of the request and, if necessary, to work together on a response.
2. Notify the Data Manager if s/he is needed to facilitate fulfilling the request in some manner.
3. Respond to the request in an official email or memo.
4. In the response, refer the requestor to the NPS Data Store and the IRMA portal (http://irma.nps.gov), so they may download the necessary data and/or metadata. If the request cannot be fulfilled in that manner – either because the data products have not

been posted yet, or because the requested data include sensitive information – work with the Data Manager to discuss options for fulfilling the request directly (e.g., writing data to CD or DVD). Ordinarily, only certified data sets should be shared outside NPS.

5. It is recommended that documents and presentation files be converted to PDF format prior to distribution. This is to maximize portability and to reduce the ability for others to alter and redistribute files.
6. If the request is for data that may reveal the location of protected resources, refer to the next section in this document about sensitive information and also to **Chapter 4J, Identifying and Handling Sensitive Information**.
7. After responding, provide the following information to the Data Manager, who will maintain a log of all requests in the NCCN project tracking database:
    a. Name and affiliation of requestor
    b. Request date
    c. Nature of request
    d. Responder
    e. Response date
    f. Nature of response
    g. List of specific data sets and products sent (if any)

Freedom of Information (FOIA) Requests

All official FOIA requests will be handled according to NPS policy. The Project Lead will work with the Data Manager and the park FOIA representative(s) of the park(s) for which the request applies.

Special Procedures for Sensitive Information

Products that have been identified upon delivery by the Project Lead as containing sensitive information will normally be revised into a form that does not disclose the locations of protected resources – most often by removing specific coordinates and only providing coordinates that include a random offset to indicate the general locality of the occurrence. If this kind of measure is not a sufficient safeguard given the nature of the product or the protected resource in question, the product(s) will be withheld from posting and distribution.

If requests for distribution of products containing sensitive information are initiated by the NPS, by another federal agency, or by another partner organization (e.g., a research scientist at a university), the unedited product (i.e., the full data set that includes sensitive information) may be shared only after a confidentiality agreement has been established between NPS and the agency, organization, or person(s) with whom the sensitive information is to be shared. Refer to **Section 4J, Identifying and Handling Sensitive Information** for more information.

References

North Coast and Cascades Network – National Park Service. 2007a. GIS Development Guidelines. USDI National Park Service. Available at: http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm

North Coast and Cascades Network – National Park Service. 2007b. GIS Product Specifications. USDI National Park Service. Available at: http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm

North Coast and Cascades Network – National Park Service. 2007c. GIS Naming Conventions. USDI National Park Service. Available at: http://science.nature.nps.gov/im/units/nccn/datamgmt_guide.cfm

SOP 11: Revising the Protocol

Revision History Log

Revision Date	Author	Changes Made	Reason for Change
Mar 2009	J. Boetsch	---	Original

Overview

This SOP describes how to make and track changes to the NCCN Intertidal Monitoring Protocol, including its accompanying SOPs. Project staff should refer to this SOP whenever edits are necessary, and should be familiar with the protocol versioning conventions in order to identify and use the most current versions of the protocol documents. Required revisions should be made in a timely manner to minimize disruptions to project operations.

Peer Review

This protocol attempts to incorporate the best and most cost-effective methods for monitoring and information management. As new technologies, methods, and equipment become available, this protocol will be updated as appropriate, by balancing current best practices against the continuity of protocol information.

All edits require review for clarity and technical soundness. Small changes to existing documents – e.g., formatting, simple clarification of existing content, minor changes to the task schedule or project budget, or general updates to information management SOPs – may be reviewed in-house by project and NCCN staff. However, changes to data collection or analysis techniques, sampling design, or response design are usually more significant in scope and impact and will typically trigger an outside review to be coordinated by the Pacific West Regional Office of the National Park Service.

Document Life Cycle

Protocol documents may be maintained as separate files for each component (e.g., narrative, SOPs, appendices in separate document files) or unified into a single document file. During its life cycle, each document file can be classified in one of six life cycle stages:

1. Draft documents – Documents that have been drafted or revised but have not been reviewed and approved yet.
2. Review documents – Draft documents that have been sent out for peer review or administrative review.

3. Active documents – The current, reviewed and accepted version of each protocol component in Microsoft Word format. These documents have been reviewed and approved at the appropriate level, and are currently implemented for active monitoring projects.
4. Inactive documents – Older versions of approved protocol components that are no longer in active implementation.
5. Archived documents – Comprehensive set of active protocol components plus older, inactive versions of approved protocol components in Microsoft Word format. These are stored as read-only and have a date stamp to identify their approval date. The history of the protocol versions through time should be entirely traceable from within the document archive.
6. Distribution copies – PDF versions of approved, date-stamped protocol components, used to post to websites or otherwise share outside NPS.

Protocol documents are stored in the project workspace in separate subfolders named for each life cycle stage, except for inactive documents which are filed together with date-stamped copies of active documents in the archive folder. See **SOP 6: Project Workspace and Records Management** for additional details about the project workspace.

Document Versioning Conventions

Rather than using a sequential numeric versioning convention, we use date stamps to distinguish document versions because they are more intuitive and informative than version numbers. Date stamps are embedded within the document header, and also included in the document name.

<u>Document Header</u>

Within each document, the upper right section of the document header should show the date that the document was last saved. By using save date instead of current date, printouts and document previews will show the correct version number. The following is the field code to be used within the header to indicate the version number:

SAVEDATE } \@ "MMMM d, yyyy"

<u>File Naming Conventions</u>

All documents <u>*except for active documents and draft documents*</u> should include the last edit date as a suffix, using the YYYYMMDD format so that documents will sort by date rather than month or day (e.g., NCCN_Intertidal_Protocol_DRAFT_20110401.doc for the review draft on 4/1/2011).

Active documents and draft documents that have not been shared with others (as review documents) should not include the date because – unlike documents in other life cycle stages – they are not "point in time" document snapshots. By omitting the date stamp from these documents, they can more easily be distinguished from review drafts and archive or distribution copies. Draft documents should clearly contain the word "DRAFT" in the file name.

Note: General file and folder naming conventions are described in **SOP 6: Project Workspace and Records Management**; these should be followed when naming protocol document files.

Revision Procedures

Proposed changes to protocol components should be discussed among project staff prior to making modifications. It is especially important to consult with the Data Manager prior to making changes because certain types of changes may jeopardize data set integrity unless they are planned and executed with the continuity of the data set in mind. Because certain changes may require altering the database structure or functionality, advance notice of changes is important to minimize disruptions to project operations. Consensus should be reached on who will be making the agreed-upon changes and in what timeframe.

Note: A change in one document also may necessitate other changes elsewhere in the protocol. For example, a change in the narrative may require changes to several SOPs; similarly renumbering an SOP may mean changing document references in several other sections of the protocol. The project task list and other appendices also may need to be updated to reflect changes in timing or responsibilities for the various project tasks.

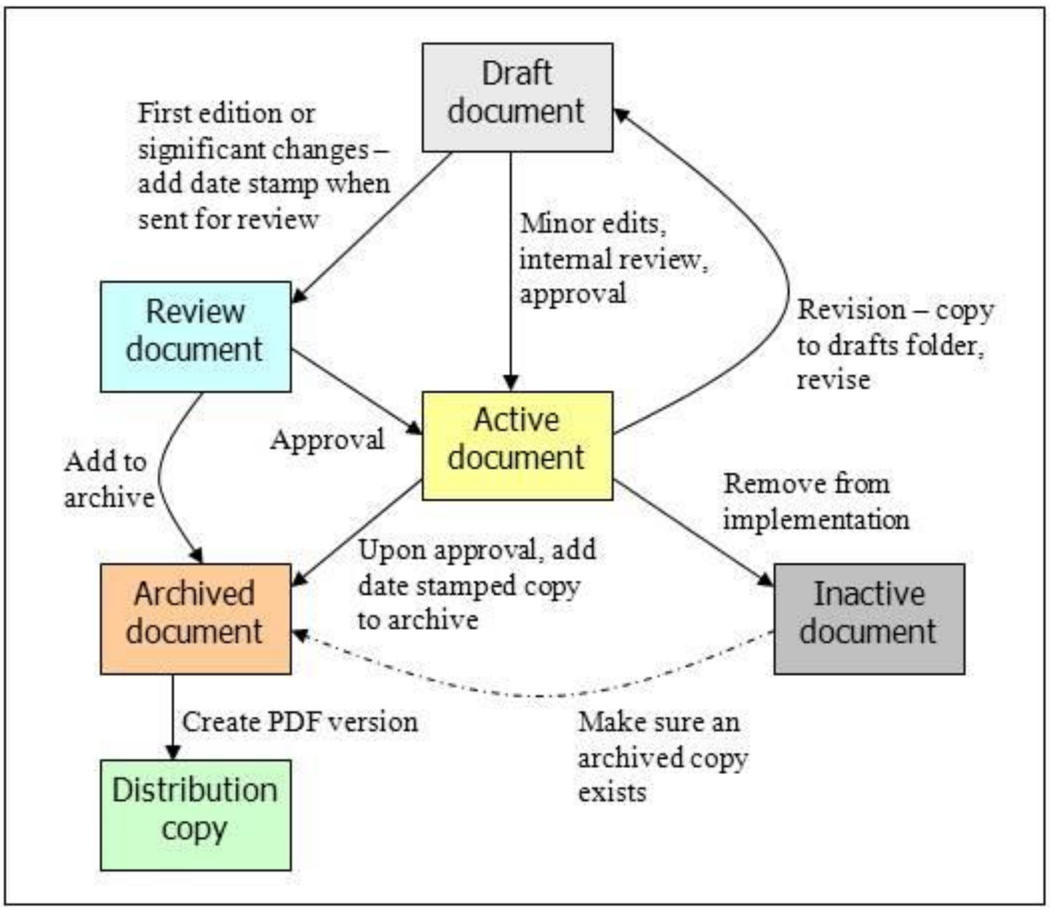

Figure S11.1. Process for creating and revising protocol documents. Boxes represent document life cycle stages, and connecting arrows indicate procedures.

The Project Lead is the primarily responsible for making edits and ensuring document review at the appropriate level. The process for creating and revising protocol documents is shown in Figure S11.1, and outlined below:

1. *Create the draft document in Microsoft Word format*. If modifying an existing document (usually an active document), copy the document to the draft document folder, remove any date stamp from the name. Add "DRAFT" to the file name. Open the document and add "DRAFT" to the header or document watermark as appropriate.

2. *Track revision history*. If modifying an existing document, document all edits in the Revision History Log embedded in the protocol narrative and each SOP. Log changes only for the section of the document being edited (i.e., if there is a change to an SOP, log those changes only in the revision history log for that SOP). Record the date of the changes (i.e., the date on which all changes were finalized), author of the revision, describe the change and cite the paragraph(s) and page(s) where changes are made, and briefly indicate the reason for making the changes.

3. *Document review*. Circulate the changed document for internal review among project staff and cooperators. If the changes are significant enough to trigger peer review (as defined above), create a review document by adding a date stamp to the end of the file name using the YYYYMMDD format, copy the file to the archive folder, and submit the document for peer review according to current instructions.

4. *Finalize and archive*. Upon approval and final changes:
    a. Ensure that the version date (last saved date field code in the document header) and file name (field code in the document footer, if used) are updated properly throughout the document.
    b. Move the approved document to the active folder. Remove the word "DRAFT" from watermarks, document headers, and file name. Remove any previous date stamp. This is now an active, implemented document.
    c. To avoid unplanned edits to the document, reset the document to read-only by right-clicking on the document in Windows Explorer and checking the appropriate box in the Properties popup.
    d. Create a copy of the file and add the revision date to the end of the file name using the YYYYMMDD format. Move this copy to the archive folder.
    e. Inform the Data Manager so the new version number can be incorporated into the project metadata.

5. *Create distribution copies*. As needed, create a PDF version of the archived document to post to the internet and share with others. These PDF versions should have the same date-stamped name as the archived Microsoft Word file. Post the distribution copy to the NCCN Digital Library and forward copies to all individuals who had been using a previous version of the affected document.

6. *Remove from implementation*. If it is decided that a document needs to be removed from implementation – either because it is no longer necessary (e.g., an unneeded SOP), or because it has been superseded by a more recent version – this can be easily done by removing the document from the active document folder, after first checking that a copy of that version already exists in the archive folder.

Appendices

Cattle Point at the south end of the American Camp Unit of SAJH.

Appendix 1. Yearly Project Task List.

This table identifies each task by project stage, indicates who is responsible, and establishes the timing for its execution. Protocol sections and SOPs are referenced as appropriate.

Project Stage	Task Description	Responsibility	Timing
Preparation (*Sections 3A, 3B and 4B; SOP 6*)	Meet (or conference call) to recap past field season, discuss the upcoming field season, and document any needed changes to field sampling protocols or the database	Project Lead, Data Manager, and GIS Specialist	by Dec 1
	Initiate announcement for seasonal field crew positions	Project Lead	Feb
	Ensure all project compliance needs are completed for the coming season	Project Lead	Feb
	Plan staffing, schedule and logistics	Project Lead	Feb
	Inform GIS Specialist and Data Manager of specific needs for upcoming field season	Project Lead	by Mar 1
	Hire seasonal field crew positions	Project Lead	by Mar 15
	Purchase equipment (temp. loggers, field gear, etc.)	Project Lead	by Mar 31
	Ensure that project workspace is ready for use (SOP 6)	Project Lead	by Apr 15
	Initiate computer access and key requests	Project Lead	by Apr 15
	Provide field crew email addresses and user logins to Data Manager	Project Lead	by Apr 15
	Generate pre-printed data forms	Project Lead	by Apr 15
	Select sand transect target coordinates, load targets into GPS units	Project Lead	by Apr 15
	Provide database/GPS training as needed	Data Manager and GIS Specialist	Apr-May
	Train field crew in invertebrate and macroalgal identification, use of equipment, sampling protocols, safety, vehicle use, and coastal travel	Project Lead	Apr-May
	Prepare and print field maps	Field Lead	Apr-May
	Update and deploy database application for data entry	Data Manager	by May 1
Data Acquisition (*Section 3C; SOPs 1-5*)	Collect field data during field trips. Review data forms for completeness and accuracy after each field day.	Technicians, Project Lead	May-Aug
	Retrieve temperature data from data loggers	Technicians	May-Aug
	Review field forms for completeness and accuracy	Field Lead	after each field trip
	De-brief crew on operations, field methods, gear needs	Project Lead	after each field trip
Data Entry & Processing (*Section 4C and 4D; SOP 5 and 7)*	Download and process digital images (SOP 7)	Technicians	after each field trip
	Download and process temperature data files, upload into the database (SOP 5)	Technicians	after each field trip
	Enter data into the database	Technicians	after each field trip

Project Stage	**Task Description**	**Responsibility**	**Timing**
Data Entry & Processing (*Section 4C and 4D; SOP 5 and 7)*	Verify accurate transcription from field forms to database as data are entered	Technicians	after each field trip
	Review database entries for completeness and accuracy	Field Lead	after each field trip
	Scan field forms as PDF documents	Field Lead	by Sep 30
	Identify and label and store voucher specimens	Field Lead	by Sep 30
	Confirm that data entry is complete, and notify the Project Lead and Data Manager	Field Lead	by Sep 30
Product Development (*Section 4I*)	Complete field season report	Field Lead	by Sep 30
Product Delivery (*Section 4K*)	Send field season report to Project Lead and Data Manager (SOP 10)	Field Lead	by Sep 30
Quality Review (*Section 4E)*	Quality review and data validation using database tools (SOP 8)	Project Lead	Oct-Nov
	Determine best coordinates for subsequent mapping and field work	Project Lead and GIS Specialist	late Oct
Metadata (*Section 4F*)	Identify any sensitive information contained in the data set (Section 4J)	Project Lead	Nov
	Update project metadata interview form	Project Lead	Nov
Data Certification & Delivery (*Section 4G; SOP 8 and 10*)	Certify the season's data and complete the certification report (SOP 8)	Project Lead	Nov
	Deliver certification report, certified data, and updated metadata to Data Manager (SOP 10)	Project Lead	by Nov 30
	Store certified data files in the project workspace (SOP 10)	Data Manager	Dec-Jan
	Finalize and parse metadata records, store in the project workspace (SOP 10)	Data Manager and GIS Specialist	by Mar 15
Data Analysis (*Section 4H*) Note: The tasks in this section occur every 5 years.	Perform trend analyses (SOP 9)	Data Analyst	Jan-Feb
Reporting & Product Development (*Section 4I*)	Export automated summary queries and reports from database	Data Analyst	Jan-Feb
	Acquire the proper report template from the NPS website (http://www.nature.nps.gov/publications/NRPM/index.cfm), draft annual report	Data Analyst and Project Lead	Feb-Apr
	Screen all reports and data products for sensitive information	Project Lead	Feb-Apr
Product Delivery (*Section 4K; SOP 10*)	Submit draft I&M report to Network Program Manager for review	Project Lead	by May 1
	Review report for formatting and completeness, notify Project Lead of approval or need for changes	Network Program Manager	May
	Upload completed report to NCCN Digital Library [1], notify Data Manager (SOP 10)	Project Lead	upon approval
	Deliver other products according to the delivery schedule and instructions (SOP 10)	Project Lead	upon completion
	Product check-in	Data Manager	upon receipt

Project Stage	Task Description	Responsibility	Timing
Posting & Distribution (*Section 4K; SOP 10*)	Submit metadata to NPS Data Store [2]	Data Manager	by Mar 15
	Create an online reference record and post reports to the NPS Data Store [2]	Data Manager	upon receipt
	Update NPSpecies [3] records according to data observations	Data Manager	Jan-Mar
	Submit certified data and GIS data sets to NPS Data Store [2]	Data Manager	Jun (after 2-year hold)
Archiving & Records Management (*Section 4L; SOP 6 and 10*)	Store finished products slated for permanent retention in NCCN Digital Library [1]	Data Manager	upon receipt
	Review, clean up and store and/or dispose of project files according to NPS Director's Order 19 [4]	Project Lead	Jan
	Move hard-copy data forms and voucher specimens to park collections	Project Lead	Jan
Season Close-out (*Section 4M*)	Inventory equipment and supplies, store gear for winter	Field Lead	by Sep 30
	De-brief field crew concerning safety, logistics, and data concerns	Project Lead, Technicians	by Sep 30
	Meet to discuss the recent field season, and document any needed changes to field sampling protocols or the database	Project Lead, Data Manager, and GIS Specialist	by Dec 1 of the same year
	Discuss and document needed changes to analysis and reporting procedures	Project Lead, Data Analyst, and Data Manager	by Mar 31

[1] The NCCN Digital Library is a document management system implemented in Microsoft SharePoint for maintaining important digital files (reports, protocol documents, and select project images) within a content management system, and to make them available to NCCN and NPS users.

[2] The NPS Data Store is an internet clearinghouse for documents, data and metadata on natural and cultural resources in parks. It is a primary component of the NPS Integrated Resource Management Applications (IRMA) portal (http://irma.nps.gov).

[3] NPSpecies is the NPS database and application for maintaining park-specific species lists and observation data, and is also a component of the IRMA portal (http://irma.nps.gov).

[4] NPS Director's Order 19 provides a schedule indicating the amount of time that the various kinds of records should be retained. Available at: http://home.nps.gov/applications/npspolicy/DOrders.cfm

Appendix 2. Intertidal Monitoring Database Documentation.

The database for this project consists of three types of tables: core tables describing the "who, where and when" of data collection, project-specific tables, and lookup tables that contain domain constraints for other tables. Although core tables are based on NCCN standards, they may contain fields, domains or descriptions that have been added or altered to meet project objectives.

The database includes the following standard tables:

tbl_Sites	Sample sites - grouped sample locations
tbl_Locations	Sample locations - places where data collection occurs
tbl_Schedule	Schedule for monitoring sites
tbl_Target_Coords	Target coordinates for sample locations
tbl_Sample_Periods	The span of dates during which data collection occurs
tbl_Events	Data collection event for a given location
tbl_Coordinates	Coordinate data collected during sampling events
tbl_GPS_Info	GPS information associated with sampling event coordinates
tbl_Observers	Observers for each sampling event
tbl_Task_List	Checklist of tasks to be completed at sampling locations
tbl_Images	Images associated with sampling events
tbl_Analysis_Notes	Sample location-specific comments related to data analysis
tbl_QA_Results	Quality assurance query results for the working data set
tbl_Edit_Log	Edit log for changes made to data after certification

The following are project-specific data tables:

tbl_Data_Logger_Events	Information associated with data logger visits
tbl_Field_Log	General information collected during site visits
tbl_Panel_Area	Plot panel area derived from raw zone measurements in rocky community plots
tbl_Rocky_Events	Information associated with rocky site visits
tbl_Rocky_Pt_Intercept	Point intercept data from rocky community plots
tbl_Rocky_Quadrats	Tallies of weakly-mobile species in rocky community plot quadrats
tbl_Sampling_Units	The array of sampling units (subplots, quadrats, or data loggers) placed at a sample location for long-term monitoring
tbl_Sand_Composition	Weight of sand sediment filtered by screen pore diameter
tbl_Sand_Core_Data	Species tallied during sand core sampling
tbl_Sand_Events	Information associated with sand site visits
tbl_Sand_Profile	Sand beach profile data
tbl_Sand_Transects	Start points for sand transect origins
tbl_Seastar_Counts	Seastar counts from MARINe seastar plots at rocky sites
tbl_Target_Sp_Intercept	MARINe target species point intercept data from rocky sites
tbl_Zone_Measurements	Raw zone measurement data for rocky community plot setup and zone area determination

The following are a few of the more prominent, standard lookup tables:

tlu_Project_Crew	List of personnel associated with a project
tlu_Project_Taxa	List of species associated with project observations
tlu_Park_Taxa	Park-specific attributes for taxa

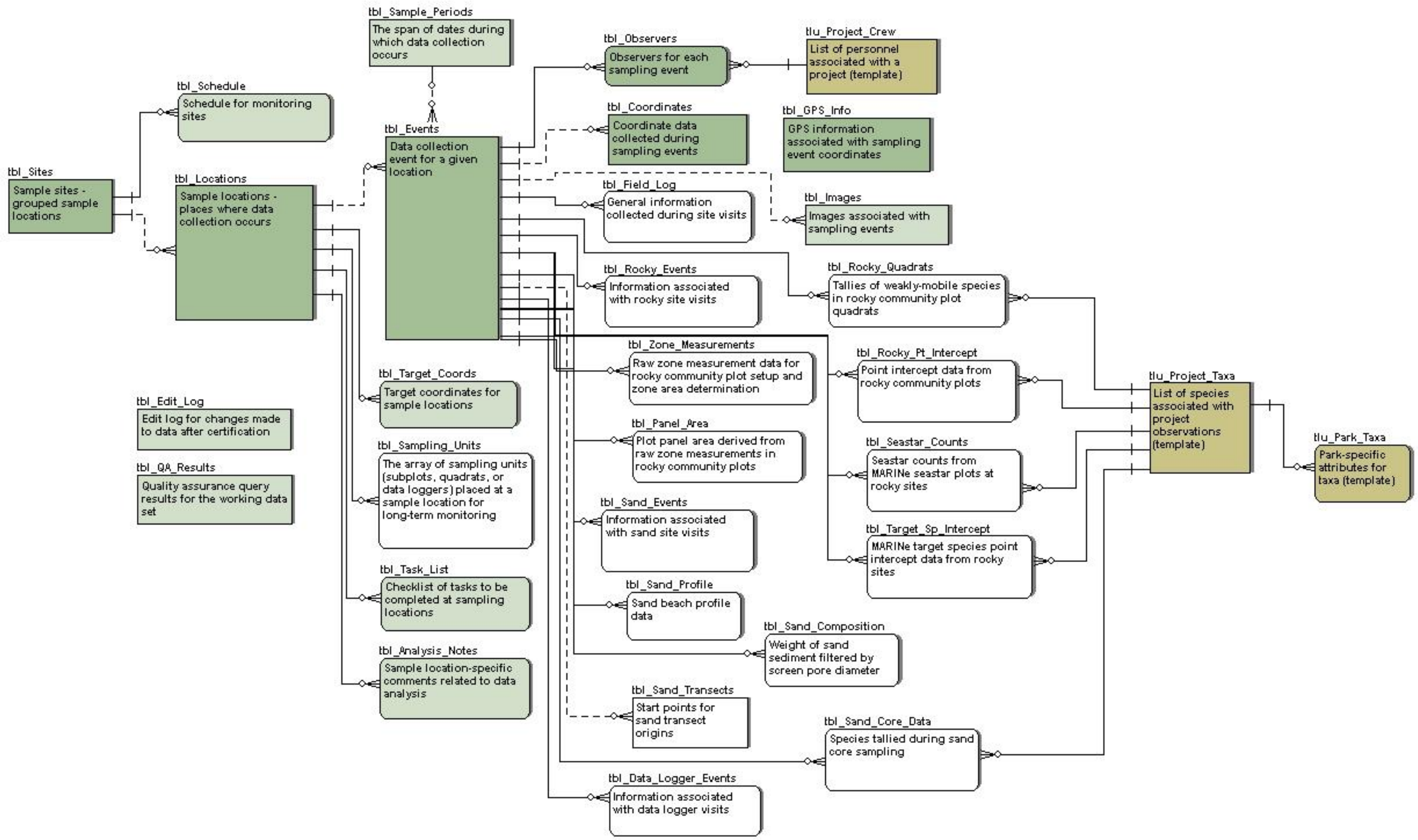

Figure A2.1. Entity relationship diagram of the project database. Relationships between tables are represented by lines. Dark green tables represent core standard tables; light green represents extended standard tables; light brown are standard lookup tables. Project-specific tables are unshaded.

Data Dictionary

Note: Required fields are denoted with an asterisk (*).

File name: Intertidal_MIa01.dm1
Report date: 11/23/2011 3:00:52 PM

tbl_Analysis_Notes - Sample location-specific comments related to data analysis

Index	*Index columns*
Location_ID	Location_ID
pk_tbl_Analysis_Notes (primary)	Location_ID, Analysis_year

Field name	*Index/key*	*Data type*	*Description*
Location_ID	primary (FK)*	text (50)	Sampling location
Analysis_year	primary *	text (4)	Analysis year (e.g., 2010)
Analysis_notes		memo	Comments about this sample location related to the specified analysis year

tbl_Coordinates - Coordinate data collected during sampling events

Index	*Index columns*
Coord_label	Coord_label
Coord_type	Coord_type
Coord_updated	Coord_updated
Datum	Datum
Event_ID (unique)	Event_ID
Field_coord_source	Field_coord_source
pk_tbl_Coordinates (primary)	Coord_ID

Field name	*Index/key*	*Data type*	*Description*
Coord_ID	primary *	text (50)	Unique identifier for each coordinate record
	Default: =Format(Now(),"yyyymmddhhnnss") & '-' & 1000000000*Rnd(Now())		
Event_ID	unique (FK)*	text (50)	Sampling event of coordinate data collection
Coord_label	indexed	text (25)	Name of the coordinate feature (e.g., plot center, NW corner)
Is_best		bit	Indicates whether this set of coordinates is the best available for this location
UTM_east		double	Final UTM easting (zone 10N, meters), including any offsets and corrections
UTM_north		double	Final UTM northing (zone 10N, meters), including any offsets and corrections
Coord_type	indexed	text (20)	Coordinate type stored in UTM_east and UTM_north: target, field, post-processed
Datumindexed	text (5)	Datum of UTM_east and UTM_north	
	Default: "NAD83"		
Est_horiz_error		double	Estimated horizontal error (meters) of UTM_east and UTM_north
Field_UTME		double	UTM easting (zone 10N) as recorded in the field
Field_UTMN		double	UTM northing (zone 10N) as recorded in the field
Field_datum		text (5)	Datum of field coordinates
Field_horiz_error		double	Field coordinate horizontal error (m)
Field_offset_m		double	Distance (meters) from the field coordinates to the target
	Constraint: Is Null Or >=0		
Field_offset_azimuth		smallint	Azimuth (degrees, declination corrected) from the coordinates to the target
	Constraint: Is Null Or (>=0 And <=360)		

Field_coord_source	indexed	text (12)	Field coordinate data source
GPS_file_name		text (50)	GPS rover file used for data downloads
GPS_model		text (25)	Make and model of GPS unit used to collect field coordinates
Source_citation		text (250)	Name, date and scale of the source map
Coordinate_notes		memo	Notes about this set of coordinates
Coord_created_date		datetime	Time stamp for record creation
	Default: Now()		
Coord_updated	indexed	datetime	Date of the last update to this record
Coord_updated_by		text (50)	Person who made the most recent edits
Elevation_m		single	Elevation in meters, derived from GIS using final UTMs
Slope_deg		single	Slope steepness in degrees, derived from GIS using final UTMs
Aspect_deg		single	Slope aspect in degrees, derived from GIS using final UTMs

tbl_Data_Logger_Events - Information associated with data logger visits

Index	*Index columns*
Event_ID	Event_ID
Logger_type	Logger_type
Next_retrieval_date	Next_retrieval_date
pk_tbl_Data_Logger_Event (primary)	Event_ID, Logger_type

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	text (50)	Sampling event
Logger_type	primary *	text (10)	Type of data logger
	Default: "Hobo"		
Was_downloaded	*	bit	Indicates whether data logger data were downloaded during the visit
Data_file		text (100)	Name of the data log file
Was_deployed	*	bit	Indicates whether a data logger was deployed during the visit
Next_retrieval_date	indexed	datetime	Date on which the newly-deployed logger must be removed or replaced
Was_retrieved	*	bit	Indicates whether a data logger was retrived during the visit
Photos_taken	*	bit	Indicates whether data logger photos were taken during the visit
Visit_notes		memo	Comments about the data logger visit

tbl_Edit_Log - Edit log for changes made to data after certification

Index	*Index columns*
pk_tbl_Edit_Log (primary)	Data_edit_ID
Project_code	Project_code
Table_affected	Table_affected
User_name	User_name
Edit_date	Edit_date
Edit_type	Edit_type

Field name	*Index/key*	*Data type*	*Description*
Data_edit_ID	primary *	text (50)	Unique identifier for each data edit record
	Default: =Format(Now(),"yyyymmddhhnnss") & '-' & 1000000000*Rnd(Now())		
Project_code	indexed *	text (10)	Project code, for linking information with other data sets and applications
	Default: "MIa01"		
Edit_date	indexed *	datetime	Date on which the edits took place
	Default: Now()		

Edit_type	indexed *	text (12)	Type of edits made: deletion, update, append, reformat, tbl design
Edit_reason	*	text (100)	Brief description of the reason for edits
User_name	indexed *	text (50)	Name of the person making data edits
Table_affected	indexed	text (50)	Table affected by edits
Fields_affected		text (200)	Description of the fields affected
Records_affected		text (200)	Description of the records affected
Data_edit_notes		memo	Comments about the data edits

tbl_Events - Data collection event for a given location

Index	*Index columns*
Certified_date	Certified_date
Entered_date	Entered_date
Location_ID	Location_ID
pk_tbl_Events (primary)	Event_ID
Start_date	Start_date
udx_tbl_Events (unique)	Location_ID, Start_date
Updated_date	Updated_date
Verified_date	Verified_date
Period_ID	Period_ID

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary *	text (50)	Unique identifier for each sampling event
	Default: =Format(Now(),"yyyymmddhhnnss") & '-' & 1000000000*Rnd(Now())		
Location_ID	unique (FK)*	text (50)	Sampling location for this event
Project_code	*	text (10)	Project code, for linking information with other data sets and applications
	Default: "MIa01"		
Start_date	unique *	datetime	Start date of the sampling event
Start_time		datetime	Start time of the sampling event
End_time		datetime	End time of the sampling event (optional)
Low_tide_ft		single	Predicted low tide value, in feet
	Constraint: Is Null Or (>=-3 And <=13)		
Low_tide_time		datetime	Predicted time of low tide
Declination		text (25)	Declination correction factor for measurement of compass bearings
Logistics_notes		memo	Comments about logistics for reaching and sampling this location
Event_notes		memo	Comments about the sampling event
Entered_by		text (50)	Person who entered the data for this event
Entered_date	indexed	datetime	Date on which data entry occurred
	Default: Now()		
Updated_by		text (50)	Person who made the most recent updates
Updated_date	indexed	datetime	Date of the most recent edits
Verified_by		text (50)	Person who verified accurate data transcription
Verified_date	indexed	datetime	Date on which data were verified
Certified_by		text (50)	Person who certified data for accuracy and completeness
Certified_date	indexed	datetime	Date on which data were certified
QA_notes		memo	Quality assurance comments for the selected sampling event
Period_ID	indexed (FK)	text (50)	Sample period during which this event occurred
Is_excluded		bit	Flag to exclude the sampling event from data summary output
	Default: False		

tbl_Field_Log - General information collected during site visits

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	text (50)	Sampling event
Swell_surge		text (5)	Relative level of water movement over the seaward portion of the site
	Default: "---"		
Wind		text (5)	Wind levels: L = 10 knots and under, M = 11-20 knots, H = over 20 knots
	Default: "---"		
Rain		text (5)	Precipitation at the site during the survey
	Default: "---"		
Wrack		text (5)	Unattached algae or other drift plants within the site
	Default: "---"		
Driftwood		text (5)	Sticks, branches and logs at the site
	Default: "---"		
Shells		text (5)	Levels of dead shells, especially mussel shells
	Default: "---"		
Dead_animals		text (5)	Levels of dead invertebrates, fish, birds or mammals
	Default: "---"		
Trash		text (5)	Human debris including cans, bottles, plastics and metal items
	Default: "---"		
Oil_tar		text (5)	Fresh or weathered oil/tar within the site
	Default: "---"		
Human_animal_notes		memo	Notes about human or animal observations
Other_notes		memo	Other site visit notes
Site_photos	*	bit	Indicates whether site photos were taken during the visit
Marker_repairs	*	bit	Indicates whether plot marker repairs were made during the visit
Sand_cores	*	bit	Indicates whether sand core observations were made during the visit
Beach_profile	*	bit	Indicates whether beach profile measurements were recorded during the visit
Sediment	*	bit	Indicates whether sand core sediments were collected during the visit
Vouchers	*	bit	Indicates whether sand core species vouchers were collected during the visit
Sand_photos	*	bit	Indicates whether sand core species photos were taken during the visit
Target_plots	*	bit	Indicates whether MARINe target species point intercept plots were collected during the visit
Field_scored	*	bit	Indicates whether the MARINe target species point intercept data were scored in the field (FALSE means that data were scored from photos back in the office)
Seastar_plots	*	bit	Indicates whether seastar plot counts were made during the visit
Zone_transects	*	bit	Indicates whether rocky community zone transects were sampled during the visit
Point_intercept	*	bit	Indicates whether rocky community point intercept data were collected during the visit
Rocky_quadrats	*	bit	Indicates whether rocky community quadrat counts were made during the visit

tbl_GPS_Info - GPS information associated with sampling event coordinates

Index	*Index columns*
Coord_ID	Coord_ID
Corr_type	Corr_type
Datum	GPS_datum
Feat_name	Feat_name
Feat_type	Feat_type
GPS_date	GPS_date
GPS_file	GPS_file
Location_ID	Location_ID
pk_tbl_GPS_Info (primary)	GPS_ID

Field name	*Index/key*	*Data type*	*Description*
GPS_ID	primary *	text (50)	Unique identifier for the GPS record
	Default: =Format(Now(),"yyyymmddhhnnss") & '-' & 1000000000*Rnd(Now())		
Location_ID	indexed	text (50)	Sample location, used for temporary links
Feat_type	indexed	text (20)	Feature type (point, line, or polygon) collected with GPS
Data_dict_name		text (50)	Data dictionary name used to collect feature
Feat_name	indexed	text (50)	Feature name in data dictionary
GPS_file	indexed	text (50)	GPS file name
GPS_date	indexed	datetime	Date GPS file was collected
GPS_time		datetime	Time GPS file was collected
Corr_type	indexed	text (50)	GPS file correction type
GPS_UTME		double	UTM easting in GPS unit
GPS_UTMN		double	UTM northing in GPS unit
UTM_zone		text (5)	UTM projection system zone
	Default: "10N"		
GPS_datum	indexed	text (5)	Datum of GPS coordinates
Elev_m		double	Elevation (meters) in GPS unit
Num_sat		smallint	Number of satellites tracked by GPS unit during data collection
GPS_duration		text (25)	Length of time GPS file was open
Filt_pos		smallint	Number of GPS positions exported from GPS file
PDOP	double	Position dilution of precision scale	
HDOP	double	Horizontal dilution of precision scale	
H_err_m		double	Horizontal error (meters)
V_err_m		double	Vertical error (meters)
Std_dev_m		double	Standard deviation (meters)
GPS_process_notes		text (255)	GPS file processing notes
Coord_ID	indexed	text (50)	Coordinate identifier
Flag *	bit	Internal flag used to identify records while matching with tbl_Coordinates during post-season processing	
	Default: False		
Is_better	*	bit	Indicates that the field crew thought this coordinate record to be an improvement over the current Is_best coordinate
	Default: False		

tbl_Images - Images associated with sampling events

Index	*Index columns*
Event_ID	Event_ID
Image_label	Image_label
Image_quality	Image_quality
Image_type	Image_type
pk_tbl_Images (primary)	Image_ID
Sort_order	Sort_order

Field name	*Index/key*	*Data type*	*Description*
Image_ID	primary *	text (50)	Unique identifier for each image record
	Default: =Format(Now(),"yyyymmddhhnnss") & '-' & 1000000000*Rnd(Now())		
Event_ID	indexed (FK)*	text (50)	Sampling event
Image_type	indexed	text (20)	Type of image
	Default: "ground photo"		
Image_label	indexed	text (25)	Image caption or label
Image_desc		text (255)	Brief description of the image bearing, perspective, etc.
Frame_number		text (10)	Frame number for photographic images
Image_date		datetime	Date on which the image was created, if different from the sampling event date
Image_source		text (50)	Name of the person or organization that created the image
Image_quality	indexed	tinyint	Quality of the image
Is_edited_version		bit	Indicates whether this version of the image is the edited (originals = False)
Object_format		text (20)	Format of the image
Orig_format		text (20)	Format of the original image
Image_edit_notes		text (200)	Comments about the editing or processing performed on the image
Image_is_active		bit	Indicates whether the image is still being used for navigation or interpretation
	Default: True		
Image_root_path		text (100)	Drive space location of the main project folder or image library
Image_project_path		text (100)	Location of the image from the main project folder or image library
	Default: "images\"		
Image_filename		text (100)	Name of the image including extention (.jpg) but without the image path
Image_notes		memo	Comments about the image
Sort_order	indexed *	int	Sort order for displaying records in the order they were entered

tbl_Locations - Sample locations - places where data collection occurs

Index	*Index columns*
Public_offset	Public_offset
Site_ID	Site_ID
udx_tbl_Locations (unique)	Location_code, Site_ID
Loc_updated	Loc_updated
Location_code	Location_code
Location_status	Location_status
Location_type	Location_type
pk_tbl_Locations (primary)	Location_ID

Field name	*Index/key*	*Data type*	*Description*
Location_ID	primary *	text (50)	Unique identifier for each sample location
	Default: =Format(Now(),"yyyymmddhhnnss") & '-' & 1000000000*Rnd(Now())		
Site_ID	unique (FK)*	text (50)	Site membership of the sample location
Location_code	unique *	text (10)	Alphanumeric code for the sample location
Location_type	indexed *	text (20)	Indicates the type of sample location
UTME_public		double	UTM easting (zone 10N, meters). Note: in addition to any measurement error, these coordinates may have been offset up to 2 km from their actual position.
UTMN_public		double	UTM northing (zone 10N, meters). Note: in addition to any measurement error, these coordinates may have been offset up to 2 km from their actual position.
Public_offset	indexed	text (50)	Type of processing performed to make coordinates publishable
Location_status	indexed *	text (10)	Status of the sample location
	Default: "active"		
Location_notes		memo	Other notes about the sample location
Loc_established		datetime	Date the sample location was established
Loc_discontinued		datetime	Date the sample location was discontinued
Loc_created_date		datetime	Time stamp for record creation
	Default: Now()		
Loc_updated	indexed	datetime	Date of the last update to this record
Loc_updated_by		text (50)	Person who made the most recent edits
Location_name		text (50)	Brief colloquial name of the sample location (optional)
Travel_notes		memo	Directions for relocating the sample location
Location_desc		memo	Environmental description of the sampling location

tbl_Observers - Observers for each sampling event

Index	*Index columns*
Contact_ID	Contact_ID
Event_ID	Event_ID
Observer_role	Observer_role
pk_tbl_Observers (primary)	Event_ID, Contact_ID, Observer_role

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	text (50)	Sampling event identifier
Contact_ID	primary (FK)*	text (50)	Observer identifier
Observer_role	primary *	text (25)	Role of the observer during data collection (optional)
Observer_notes		text (200)	Comments about the observer specific to this sampling event

tbl_Panel_Area - Plot panel area derived from raw zone measurements in rocky community plots

Index	*Index columns*
Event_ID	Event_ID
Panel_code	Panel_code
Zone_code	Zone_code
pk_tbl_Panel_Area (primary)	Event_ID, Panel_code, Zone_code

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	text (50)	Sampling event
Panel_code	primary *	tinyint	Plot panel
Zone_code	primary *	text (1)	Life zone
Area_m2		double	Calculated area, in square meters
	Constraint: Is Null Or (>=0 And <=20)		
Comments		text (50)	Comments about the panel area calculation
Updated_date		datetime	Date stamp for the most recent edits to the calculation
	Default: Now()		
Updated_by		text (50)	Person who made the most recent updates

tbl_QA_Results - Quality assurance query results for the working data set

Index	*Index columns*
pk_tbl_QA_Results (primary)	Query_name, Time_frame, Data_scope
Query_name	Query_name
Query_result	Query_result
Query_type	Query_type
Time_frame	Time_frame
Data_scope	Data_scope

Field name	*Index/key*	*Data type*	*Description*
Query_name	primary *	text (100)	Name of the quality assurance query
Time_frame	primary *	text (30)	Field season year or range of dates for the data being passed through quality assurance checks
Query_type	indexed	text (20)	Severity of data errors being trapped: 1=critical, 2=warning, 3=information
Query_result	indexed	text (50)	Query result as the number of records returned the last time the query was run
Query_run_time		datetime	Run time of the query results
Query_description		memo	Description of the query
Query_expression		memo	Evaluation expression built into the query
Remedy_desc		memo	Details about actions taken and/or not taken to resolve errors
Remedy_date		datetime	When the remedy description was last edited
QA_user		text (50)	Name of the person doing quality assurance
Is_done	*	bit	Temporary flag to indicate that the user is done reviewing this query even if some records remain
Data_scope	primary *	tinyint	Scope of the data included in queries: 0=Uncertified events only, 1=Both certified and uncertified, 2=Certified events only

tbl_Rocky_Events - Information associated with rocky site visits

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	text (50)	Sampling event
Rocky_event_notes		memo	Comments about the rocky site visit
Plot_setup_notes		memo	Comments about the rocky community plot setup

tbl_Rocky_Pt_Intercept - Point intercept data from rocky community plots

Index	*Index columns*
Event_ID	Event_ID
Panel_code	Panel_code
Sort_order	Sort_order
Taxon_ID	Taxon_ID
Zone_code	Zone_code
pk_tbl_Rocky_Pt_Intercept (primary)	Event_ID, Panel_code, Zone_code, Taxon_ID

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	text (50)	Sampling event
Panel_code	primary *	tinyint	Plot panel
Zone_code	primary *	text (1)	Elevation zone
Taxon_ID	primary (FK)*	text (50)	Taxon observed
Layer1	*	tinyint	Number of point contacts as the topmost species
	Constraint: >=0 And <=100		
Layer2	*	tinyint	Number of point contacts as the lowermost species
	Default: 0		
	Constraint: >=0 And <=100		
Sort_order	indexed *	int	Sort order for displaying records in the order they were entered

tbl_Rocky_Quadrats - Tallies of weakly-mobile species in rocky community plot quadrats

Index	*Index columns*
Event_ID	Event_ID
Panel_code	Panel_code
Quadrat	Quadrat
Sort_order	Sort_order
Taxon_ID	Taxon_ID
Zone_code	Zone_code
pk_tbl_Rocky_Quadrats (primary)	Event_ID, Panel_code, Zone_code, Quadrat, Taxon_ID

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	text (50)	Sampling event
Panel_code	primary *	tinyint	Plot panel
Zone_code	primary *	text (1)	Elevation zone
Quadrat	primary *	tinyint	Quadrat replicate number
	Constraint: >0 And <=5		
Taxon_ID	primary (FK)*	text (50)	Taxon observed
Tally *	smallint	Number of individuals observed	
	Constraint: >0 And <=2000		
Sort_order	indexed *	int	Sort order for displaying records in the order they were entered

tbl_Sample_Periods - The span of dates during which data collection occurs

Index	*Index columns*
Period_updated	Period_updated
Protocol_version	Protocol_version
Start_date	Start_date
pk_tbl_Sample_Periods (primary)	Period_ID

Field name	*Index/key*	*Data type*	*Description*
Period_ID	primary *	text (50)	Unique identifier for each sample period
	Default: =Format(Now(),"yyyymmddhhnnss") & '-' & 1000000000*Rnd(Now())		
Start_date	indexed *	datetime	Start date of the sample period
End_date	*	datetime	End date of the sample period

Trip_purpose		text (200)	Brief description of the purpose of the trip
Protocol_version	indexed	text (100)	Version of the protocol used for sampling
Trip_notes		memo	Details about the trip
Period_created		datetime	Time stamp for record creation
	Default: Now()		
Period_updated	indexed	datetime	Date of the last update to this record
Period_updated_by		text (50)	Person who made the most recent edits

tbl_Sampling_Units - The array of sampling units (subplots, quadrats, or data loggers) placed at a sample location for long-term monitoring

Index	*Index columns*
Location_ID	Location_ID
Unit_code	Unit_code
Unit_status	Unit_status
Unit_type	Unit_type
pk_tbl_Sampling_Units (primary)	Location_ID, Unit_code

Field name	*Index/key*	*Data type*	*Description*
Location_ID	primary (FK)*	text (50)	Sample location
Unit_code	primary *	text (5)	Field code for the unit
Unit_type	indexed *	text (20)	Type of unit
Unit_status	indexed *	text (10)	Current status of the sampling unit
	Default: "Active"		
Unit_notes		memo	Comments about the sampling unit
Unit_installed		datetime	Date the unit was first installed
Unit_removed		datetime	Date the unit was removed from service
Unit_updated		datetime	Date the record was last updated
	Default: Now()		

tbl_Sand_Composition - Weight of sand sediment filtered by screen pore diameter

Index	*Index columns*
pk_tbl_Sand_Composition (primary)	Event_ID, Station, Screen_size
Screen_size	Screen_size
Sort_order	Sort_order
Event_ID	Event_ID
Station	Station

Field name	*Index/key*	*Data type*	*Description*
Screen_size	primary *	text (6)	Sediment screen pore diameter
Net_wt_g		double	Net weight of the sample (not including tare weight), in grams
	Constraint: Is Null Or (>=0 And <=1500)		
Sort_order	indexed *	int	Sort order for displaying records in the order they were entered
Event_ID	primary (FK)*	text (50)	Sampling event
Station	primary *	text (5)	Sand transect sampling station

tbl_Sand_Core_Data - Species tallied during sand core sampling

Index	*Index columns*
Core_code	Core_code
Event_ID	Event_ID
Sort_order	Sort_order
Station	Station
Taxon_ID	Taxon_ID
pk_tbl_Sand_Cord_Data (primary)	Event_ID, Station, Core_code, Taxon_ID

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	text (50)	Sampling event
Station	primary *	text (5)	Sand transect sampling station
Core_code	primary *	text (1)	Sand core identifier
Taxon_ID	primary (FK)*	text (50)	Taxon observed
Tally	smallint	Number of individuals observed	
	Constraint: Is Null Or (>=0 And <=1000)		
Unsuitable		bit	Flag to indicate that the station core position was not suitable for sampling
	Default: False		
Obs_notes		text (50)	Comments about the observation record
Sort_order	indexed *	int	Sort order for displaying records in the order they were entered

tbl_Sand_Events - Information associated with sand site visits

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	text (50)	Sampling event
Tide_meas_time		datetime	Time at which the height at water line was measured
Height_ft		single	Measured distance between the sand surface at water level and the auto-level reference beam, in feet
	Constraint: Is Null Or (>=0 And <=20)		
Dist_to_water_m		single	Point along the meter tape at which the height at water line was measured
	Constraint: Is Null Or (>=0 And <=300)		
Tide_ref_location		text (20)	Location used as a reference point to look up predicted tidal elevation
Ref_tide_time		datetime	Time associated with the reference location tidal elevation value
Ref_tide_elev_ft		single	Reference location tidal elevation value, in feet
	Constraint: Is Null Or (>=-3 And <=15)		
Sand_event_notes		memo	Comments about the sand site visit
Sand_core_notes		memo	Comments about sand core species data collection

tbl_Sand_Profile - Sand beach profile data

Index	*Index columns*
Event_ID	Event_ID
pk_tbl_Sand_Profile (primary)	Event_ID, Station
Station	Station
Sort_order	Sort_order

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	text (50)	Sampling event
Station	primary *	text (5)	Sand transect sampling station
Height_ft		double	Measured distance between the sand surface and the auto-level reference beam, in feet
	Constraint: Is Null Or (>=0 And <=20)		
Elev_ft		double	Calculated elevation of the transect station, in feet

Constraint: Is Null Or (>=-3 And <=17)

Sort_order	indexed *	int	Sort order for displaying records in the order they were entered

tbl_Sand_Transects - Start points for sand transect origins

Index	*Index columns*
Event_ID	Event_ID
Firing_order	Firing_order
pk_tbl_Sand_Transects (primary)	Record_ID

Field name	*Index/key*	*Data type*	*Description*
Record_ID	primary *	int	Unique record ID
Event_ID	indexed (FK)*	text (50)	Sampling event
UTME	*	int	UTM easting (zone 10N, meters) of the transect start point
	Constraint: >=100000 And <=999999		
UTMN	*	int	UTM northing (zone 10N, meters) of the transect start point
	Constraint: >=1000000 And <=9999999		
Firing_order	indexed	smallint	Transect selection and evaluation order
Selected	*	bit	Flag to indicate that the sand transect was selected for sampling
	Default: False		
Comments		text (100)	Comments about the transect start point

tbl_Schedule - Schedule for monitoring sites

Index	*Index columns*
Calendar_year	Calendar_year
Site_ID	Site_ID
pk_tbl_Schedule (primary)	Calendar_year, Site_ID

Field name	*Index/key*	*Data type*	*Description*
Calendar_year	primary *	text (10)	Calendar year for scheduled sampling (not necessarily actually sampled)
Site_ID	primary (FK)*	text (50)	Monitoring site
Schedule_notes		text (255)	Comments about this schedule item (especially for out-of-rotation sites)

tbl_Seastar_Counts - Seastar counts from MARINe seastar plots at rocky sites

Index	*Index columns*
Event_ID	Event_ID
Morph_code	Morph_code
Plot_num	Plot_num
Size_class	Size_class
Sort_order	Sort_order
Taxon_ID	Taxon_ID
pk_tbl_Seastart_Counts (primary)	Event_ID, Plot_num, Taxon_ID, Morph_code, Size_class

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	text (50)	Sampling event
Plot_num	primary *	tinyint	Plot number within which observations were made
	Constraint: 1 Or 2 Or 3		
Taxon_ID	primary (FK)*	text (50)	Taxon observed
Morph_code	primary *	text (2)	Morph color (NA for non-Pisaster species)
Size_class	primary *	tinyint	Size class (0 for non-Pisaster species)
N_obs *	smallint	Number of seastars observed	
	Constraint: >=0 And <=1000		
Obs_notes		text (50)	Comments about the observation record

Sort_order	indexed *	int	Sort order for displaying records in the order they were entered

tbl_Sites - Sample sites - grouped sample locations

Index	*Index columns*
Park_code	Park_code
pk_tbl_Sites (primary)	Site_ID
Site_status	Site_status
Site_updated	Site_updated
udx_tbl_Sites (unique)	Site_code
Display_order	Display_order
Panel_name	Panel_name
Panel_type	Panel_type
Park_region	Park_region
Substrate	Substrate

Field name	*Index/key*	*Data type*	*Description*
Site_ID	primary *	text (50)	Unique site identifier
	Default: =Format(Now(),"yyyymmddhhnnss") & '-' & 1000000000*Rnd(Now())		
Park_code	indexed *	text (4)	Park in which the site is located
Site_code	unique *	text (10)	Unique alphanumeric code for each site
Site_name		text (25)	Brief colloquial name of the site
Site_status	indexed *	text (10)	Status of the site (i.e., proposed, active, rejected, retired)
	Default: "active"		
Site_notes		memo	Comments about the site
Site_established		datetime	Date the sample site was established
Site_discontinued		datetime	Date the sample site was discontinued
Site_created_date		datetime	Time stamp for record creation
	Default: Now()		
Site_updated	indexed	datetime	Date of the last update to this record
Site_updated_by		text (50)	Person who made the most recent edits
Display_order	indexed	tinyint	For displaying records in geographic order from north to south
Park_region	indexed	text (25)	Region of the park in which the site is located
Substrate	indexed	text (20)	Site substrate, used for site selection and grouping
Panel_type	indexed	text (20)	Sampling panel for the site
Panel_name	indexed	text (10)	Name of the sampling panel, used to group data for analysis

tbl_Target_Coords - Target coordinates for sample locations

Index	*Index columns*
pk_tbl_Target_Coords (primary)	Location_ID
Target_updated	Target_updated

Field name	*Index/key*	*Data type*	*Description*
Location_ID	primary (FK)*	text (50)	Sample location
Target_UTME		double	Target UTM easting (zone 10N)
Target_UTMN		double	Target UTM northing (zone 10N)
Target_datum		text (5)	Target coordinate datum
	Default: "NAD83"		
Target_notes		memo	Notes about the target coordinates
Target_created_date		datetime	Time stamp for record creation
	Default: Now()		
Target_updated	indexed	datetime	Date of the last update to this record
Target_updated_by		text (50)	Person who made the most recent edits

tbl_Target_Sp_Intercept - MARINe target species point intercept data from rocky sites

Constraints: : IsNull([Taxon_2]) Or ([Taxon_2]<>[Taxon_ID])

Index	*Index columns*
Assemblage	Assemblage
Event_ID	Event_ID
Plot_num	Plot_num
Sort_order	Sort_order
Taxon_2	Taxon_2
Taxon_ID	Taxon_ID
pk_tbl_Target_Sp_Contacts (primary)	Event_ID, Assemblage, Plot_num, Taxon_ID, Taxon_2

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	text (50)	Sampling event
Assemblage	primary *	text (1)	Target species assemblage (e.g., mussels, barnacles, rockweeds)
Plot_num	primary *	tinyint	Plot number within which observations were made
	Constraint: >=1 And <=5		
Taxon_ID	primary (FK)*	text (50)	Taxon observed in the uppermost layer
Taxon_2	primary *	text (50)	Second taxon observed beneath the uppermost layer
	Default: "None"		
Tally *	tinyint	Number of overlay intercept points	
	Constraint: >0 And <=100		
Sort_order	indexed *	int	Sort order for displaying records in the order they were entered

tbl_Task_List - Checklist of tasks to be completed at sampling locations

Index	*Index columns*
Date_completed	Date_completed
pk_tbl_Task_List (primary)	Location_ID, Request_date, Task_desc
Task_status	Task_status

Field name	*Index/key*	*Data type*	*Description*
Location_ID	primary (FK)*	text (50)	Sampling location
Request_date	primary *	datetime	Date of the task request
	Default: Now()		
Task_desc	primary *	text (100)	Brief description of the task
Requested_by		text (50)	Name of the person making the initial request
Task_status	indexed *	text (50)	Status of the task
	Default: "active"		
Date_completed	indexed	datetime	Date the task was completed
Followup_by		text (50)	Name of the person following up on or completing the task
Task_notes		memo	Notes about the task
Followup_notes		memo	Comments regarding what was done to follow-up on or complete this task

tbl_Zone_Measurements - Raw zone measurement data for rocky community plot setup and zone area determination

Index	*Index columns*
Event_ID	Event_ID
Sort_order	Sort_order
Transect_code	Transect_code
Zone_edge	Zone_edge
pk_tbl_Zone_Measurements (primary)	Event_ID, Transect_code, Zone_edge

Field name	*Index/key*	*Data type*	*Description*
Event_ID	primary (FK)*	text (50)	Sampling event
Transect_code	primary *	tinyint	Vertical transect
Zone_edge	primary *	text (3)	Elevation zone boundary
Dist_m		double	Distance along the meter tape, in meters
	Constraint: Is Null Or (>=0 And <=50)		
Comments		text (50)	Comments about the zone boundary measurement
Sort_order	indexed *	int	Sort order for displaying records in the order they were entered

tlu_Assemblage_Code - List of morph color codes for Pisaster ochraceus seastars

Field name	*Index/key*	*Data type*	*Description*
Assemblage_code	primary *	text (1)	
Assemblage_desc		text (100)	
Sort_order		tinyint	

tlu_Condition_Code - List of beach visit condition codes

Field name	*Index/key*	*Data type*	*Description*
Condition_code	primary *	text (5)	
Condition_desc		text (100)	
Sort_order		tinyint	

tlu_Coord_Source - List of coordinate data sources (standard)

Field name	*Index/key*	*Data type*	*Description*
Coord_source	primary *	text (12)	
Coord_source_desc		text (100)	
Sort_order		tinyint	

tlu_Coord_Type - List of coordinate types (standard)

Field name	*Index/key*	*Data type*	*Description*
Coord_type	primary *	text (20)	
Coord_type_desc		text (100)	
Sort_order		tinyint	

tlu_Core_Code - List of sand core codes

Field name	*Index/key*	*Data type*	*Description*
Core_code	primary *	text (2)	

tlu_Data_Logger_Type - List of data logger type codes

Field name	*Index/key*	*Data type*	*Description*
Data_logger_type	primary *	text (10)	
Data_logger_desc		text (200)	
Sort_order		tinyint	

tlu_Datum - List of coordinate datum codes (standard)

Field name	*Index/key*	*Data type*	*Description*
Datumprimary *	text (5)		
Datum_desc		text (50)	
Sort_order		tinyint	

tlu_Edit_Type - List of the types of post-certification edits made to data (standard)

Field name	*Index/key*	*Data type*	*Description*
Edit_type	primary *	text (12)	
Edit_type_desc		text (100)	
Sort_order		tinyint	

tlu_GPS_Model - List of GPS devices used to collect coordinate data (template)

Field name	*Index/key*	*Data type*	*Description*
GPS_model	primary *	text (25)	
Sort_order		tinyint	

tlu_Image_Format - List of image, map, and photographic formats (template)

Field name	*Index/key*	*Data type*	*Description*
Image_format	primary *	text (12)	
Image_format_desc		text (100)	
Sort_order		tinyint	

tlu_Image_Quality - List of quality ranks for images (template)

Field name	*Index/key*	*Data type*	*Description*
Quality_code	primary *	tinyint	
Image_quality	*	text (20)	
Image_quality_desc		text (100)	

tlu_Image_Type - List of image types (template)

Field name	*Index/key*	*Data type*	*Description*
Image_type	primary *	text (12)	
Image_type_desc		text (100)	
Sort_order		tinyint	

tlu_Location_Type - List of location type codes (template)

Field name	*Index/key*	*Data type*	*Description*
Location_type	primary *	text (20)	
Loc_type_desc		text (200)	
Sort_order		tinyint	

tlu_Morph_Code - List of morph color codes for Pisaster ochraceus seastars

Field name	*Index/key*	*Data type*	*Description*
Morph_code	primary *	text (2)	
Morph_desc		text (100)	
Sort_order		tinyint	

tlu_Observer_Role - List of observer role assignments (template)

Field name	*Index/key*	*Data type*	*Description*
Observer_role	primary *	text (25)	
Role_desc		text (100)	
Sort_order		tinyint	

tlu_Origin_Code - List of origin codes for park taxa (standard)

Field name	*Index/key*	*Data type*	*Description*
Origin_code	primary *	text (16)	
Origin_desc		text (100)	
NPSpp_ID		smallint	
Sort_order		tinyint	

tlu_Panel_Code - List of panel codes for rocky community plots

Field name	*Index/key*	*Data type*	*Description*
Panel_code	primary *	tinyint	

tlu_Panel_Type - List of sampling panel types (template)

Field name	*Index/key*	*Data type*	*Description*
Panel_type	primary *	text (20)	
Panel_type_desc		text (200)	
Sort_order		tinyint	

tlu_Parks - List of NCCN parks and park codes (standard)

Field name	*Index/key*	*Data type*	*Description*
Park_code	primary *	text (4)	
Park_name		text (50)	

tlu_Park_Taxa - Park-specific attributes for taxa (template)

Index	*Index columns*
Park_origin	Park_origin
Park_status	Park_status
pk_tlu_Park_Taxa (primary)	Taxon_ID, Park_code
Record_status	Record_status

Field name	*Index/key*	*Data type*	*Description*
Taxon_ID	primary (FK)*	text (50)	Taxon identifier
Park_code	primary *	text (4)	Park code
Park_status	indexed	text (16)	Status of the taxon in this park (from NPSpecies)
	Default: "unknown"		
Park_origin	indexed	text (16)	Origin of the taxon in this park (from NPSpecies)
	Default: "unspecified"		
Local_list		bit	Indicates that the taxon is the preferred one for use at the park (from NPSpecies)
Local_accepted_TSN		int	Taxonomic serial number of the local preferred taxon (from NPSpecies)
Preferred_sci_name		text (255)	Preferred scientific name of the taxon at the park (from NPSpecies)
Park_taxon_notes		memo	Comments about the taxon specific to this park
Record_status	indexed	text (16)	Indicates the status of the record in terms of synchrony with master databases
	Default: "new record"		
Created_date		datetime	Time stamp for record creation
	Default: Now()		
Updated_date		datetime	Date of the last update to this record
Updated_by		text (50)	Person who made the most recent edits

tlu_Park_Taxon_Status - List of codes for park species occurrence (standard)

Field name	*Index/key*	*Data type*	*Description*
Taxon_status_code	primary *	text (16)	
Taxon_status_desc		text (250)	
NPSpp_ID		smallint	

Sort_order		tinyint	

tlu_Project_Crew - List of personnel associated with a project (template)

Index	*Index columns*
Contact_location	Contact_location
Contact_updated	Contact_updated
First_name	First_name
Last_name	Last_name
Organization	Organization
pk_tlu_Project_Crew (primary)	Contact_ID
Project_code	Project_code

Field name	*Index/key*	*Data type*	*Description*
Contact_ID	primary *	text (50)	Unique identifier for the individual (Lastname_Firstname_MI)
Project_code	indexed *	text (10)	Project code, for linking information with other data sets and applications
	Default: "MIa01"		
Last_name	indexed *	text (24)	Last name
First_name	indexed	text (20)	First name
Middle_init		text (4)	Middle initials
Organization	indexed	text (50)	Employer (e.g., NPS-MORA)
Position_title		text (50)	Position title held by the individual
Email	text (50)	Email address	
Work_voice		text (25)	Work phone number
Work_ext		text (5)	Work extension number
Mobile_voice		text (25)	Mobile phone number
Home_voice		text (25)	Home phone number
Fax	text (25)	Fax number	
Contact_location	indexed	text (255)	Where the individual is located
Contact_notes		memo	Notes about the contact
Contact_created		datetime	Time stamp for record creation
	Default: Now()		
Contact_updated	indexed	datetime	Date of the last update to this record
Contact_updated_by		text (50)	Person who made the most recent edits
Contact_is_active		bit	Indicates that the contact record is currently available for data entry pick lists
	Default: True		

tlu_Project_Taxa - List of species associated with project observations (template)
Constraints: : ([Taxon_is_active] And [Refers_to] Is Null) Or ([Taxon_is_active]=False And [Refers_to] Is Not Null)

Index	*Index columns*
Taxon_type	Taxon_type
TSN	TSN
Accepted_TSN	Accepted_TSN
Category	Category
pk_tlu_Project_Taxa (primary)	Taxon_ID
Project_code	Project_code
Record_status	Record_status
Scientific_name (unique)	Scientific_name
Species_code (unique)	Species_code
Subcategory	Subcategory

Field name	*Index/key*	*Data type*	*Description*
Taxon_ID	primary *	text (50)	Unique identifier for each taxon
	Default: =Format(Now(),"yyyymmddhhnnss") & '-' & 1000000000*Rnd(Now())		
Project_code	indexed *	text (10)	Project code, for linking information with other data sets and applications
	Default: "MIa01"		
Species_code	unique *	text (20)	Unique field code for each project taxon
Scientific_name	unique *	text (100)	Scientific name of the taxon (from ITIS/NPSpecies)
Common_name		text (100)	Common name for the taxon (from ITIS/NPSpecies)
Pref_com_name		text (100)	Preferred common name for this project
TSN indexed	int	ITIS taxonomic serial number or a provisional number (from NPSpecies)	
Accepted_TSN	indexed	int	ITIS taxonomic serial number of the accepted name for this taxon (from NPSpecies)
Category	indexed *	text (20)	General category of the taxon (from NPSpecies)
	Default: "unspecified"		
Subcategory	indexed	text (20)	Subcategory specific to the needs of each taxonomic discipline (from NPSpecies)
Authority		text (60)	Taxonomic authority (from ITIS)
Authority_subsp		text (60)	Taxonomic authority for subspecific taxa (from ITIS)
Family		text (60)	Taxonomic family (from ITIS)
Taxon_type	indexed *	text (12)	Indicates the taxonomic resolution and certainty represented by this record
	Default: "specific"		
Taxon_notes		memo	General notes about the taxon
Created_date		datetime	Time stamp for record creation
	Default: Now()		
Updated_date		datetime	Date of the last update to this record
Updated_by		text (50)	Person who made the most recent edits
Taxon_is_active		bit	Indicates that the record is currently available for data entry pick lists
	Default: True		
Record_status	indexed	text (16)	Indicates the status of the record in terms of synchrony with master databases
	Default: "new record"		
Refers_to		text (50)	Valid taxon the record should refer to for analysis and summaries
Rec_status_notes		text (255)	Notes about the disposition of the record
Project_taxon_notes		memo	Project-specific comments about the taxon

tlu_Sand_Taxa - List of taxa commonly observed in sand transects

Field name	*Index/key*	*Data type*	*Description*
Taxon_ID	primary *	text (50)	

tlu_Screen_Size - List of sand filter pore diameters

Field name	*Index/key*	*Data type*	*Description*
Screen_size	primary *	text (6)	
Screen_size_desc		text (100)	
Sort_order		tinyint	
Is_active		bit	Indicates that the record is currently available for auto-appending
	Default: True		

tlu_Seastar_Taxa - List of commonly observed seastar taxa

Field name	*Index/key*	*Data type*	*Description*
Taxon_ID	primary *	text (50)	

tlu_Site_Status - List of status codes for sampling stations (standard)

Field name	*Index/key*	*Data type*	*Description*
Site_status	primary *	text (10)	
Site_status_desc		text (200)	
Sort_order		tinyint	

tlu_Size_Class - List of size class codes for seastar observations, used to indicate arm length in millimeters

Field name	*Index/key*	*Data type*	*Description*
Size_class	primary *	tinyint	

tlu_Station_Code - List of sand transect profile stations

Field name	*Index/key*	*Data type*	*Description*
Station_code	primary *	text (5)	
Station_desc		text (100)	
Sort_order		tinyint	

tlu_Taxon_Category - List of taxonomic categories (standard)

Field name	*Index/key*	*Data type*	*Description*
Category	primary *	text (20)	
Category_desc		text (100)	
NPSpp_ID		smallint	
Sort_order		tinyint	

tlu_Taxon_Rec_Status - List of status codes for taxon records (standard)

Field name	*Index/key*	*Data type*	*Description*
Record_status_code	primary *	text (16)	
Record_status_desc		text (200)	
Sort_order		tinyint	

tlu_Taxon_Type - List of taxon resolution codes (standard)

Field name	*Index/key*	*Data type*	*Description*
Taxon_type	primary *	text (12)	
Taxon_type_desc		text (200)	
Sort_order		tinyint	

tlu_Tide_Ref_Station - List of tide height reference stations used to determine tidal elevation and beach profile elevations

Field name	*Index/key*	*Data type*	*Description*
Tide_station	primary *	text (20)	
Tide_station_name		text (100)	
Sort_order		tinyint	

tlu_Transect_Code - List of codes for vertical transects at rocky community plots

Field name	*Index/key*	*Data type*	*Description*
Transect_code	primary *	tinyint	

tlu_Unit_Status - List of status codes for sampling units

Field name	*Index/key*	*Data type*	*Description*
Unit_status	primary *	text (10)	
Unit_status_desc		text (100)	
Sort_order		tinyint	

tlu_Unit_Type - List of sampling unit types

Field name	*Index/key*	*Data type*	*Description*
Unit_type	primary *	text (20)	
Unit_desc		text (100)	
Sort_order		tinyint	

tlu_Zone_Code - List of zone codes for rocky community plots

Field name	*Index/key*	*Data type*	*Description*
Zone_code	primary *	text (1)	
Zone_desc		text (100)	
Sort_order		tinyint	

tlu_Zone_Edge_Code - List of zone edge codes for rocky community zone measurements

Field name	*Index/key*	*Data type*	*Description*
Zone_edge_code	primary *	text (3)	
Zone_edge_desc		text (100)	
Sort_order		tinyint	

tsys_App_Releases - Application table - Application release history

Index	*Index columns*
udx_tsys_App_Releases (unique)	Release_date, Database_title, Version_number
pk_tsys_App_Releases (primary)	Release_ID

Field name	*Index/key*	*Data type*	*Description*
Release_ID	primary *	text (50)	Unique identifier for the release
	Default: =Format(Now(),"yyyymmddhhnnss") & '-' & 1000000000*Rnd(Now())		
Release_date	unique *	datetime	Date of the release
Database_title	unique *	text (100)	Title of the database
Version_number	unique *	text (20)	Version control number
File_name		text (50)	Filename, used to identify older versions of the database
Release_by		text (50)	Person who issued the release
Release_notes		memo	Release notes, which may include a summary of revisions
Is_supported	*	tinyint	Indicates the support level of this release: 0=user must use a newer version; 1=supported but newer available; 2=full suport, current version
	Default: 2		

tsys_Bug_Reports - Application table - Application bugs and development history

Index	*Index columns*
Fix_date	Fix_date
Release_ID	Release_ID
Report_date	Report_date
pk_tsys_Bug_Reports (primary)	Bug_ID

Field name	*Index/key*	*Data type*	*Description*
Bug_ID	primary *	text (50)	Unique identifier for each bug record
	Default: =Format(Now(),"yyyymmddhhnnss") & '-' & 1000000000*Rnd(Now())		
Release_ID	indexed (FK)*	text (50)	Database release version of the report
Report_date	indexed *	datetime	Date the bug was reported
	Default: =Date()		
Found_by		text (50)	Person who found the bug
Reported_by		text (50)	Person who filled out this bug report
Report_details		memo	Nature of the bug report
Fix_date	indexed	datetime	Date the bug was fixed
Fixed_by		text (50)	Person who fixed the bug
Fix_details		memo	Notes on fix

tsys_Logins - Application table - Log of user access to the database through the front-end

Field name	*Index/key*	*Data type*	*Description*
Time_stamp	primary *	datetime	Time stamp of activity record
	Default: Now()		
User_name	primary *	text (50)	Login name of the user
Action_taken		text (50)	Action taken by the user

tsys_User_Roles - Application table - Determines user access privileges through the front-end

Field name	*Index/key*	*Data type*	*Description*
User_name	primary *	text (50)	Network login
User_role	*	text (50)	Database application role, used to determine the access level

Appendix 3. Supplementary Materials

Two supplementary documents are available as background to the legacy trend and power analyses conducted on historical OLYM intertidal data. Please contact Steven_Fradkin@nps.gov for electronic versions of these documents.

Supplement 1: (Legacy Trend Analysis): Nielson, R. and L. McDonald. 2005. Trend analyses of Olympic National park intertidal monitoring data. Report to Olympic National Park and the U.S. Geological Survey. West Inc., Cheyenne, WY. May 31, 2005. 43pp.

Supplement 2: (Legacy Power Analysis): Nielson, R. and L. McDonald. 2005. Power analyses of Olympic National park intertidal monitoring data. Report to Olympic National Park and the U.S. Geological Survey. West Inc., Cheyenne, WY. May 31, 2005. 36pp.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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U.S. Department of the Interior

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